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(54) Abstract Title

Vibration damping device in a hydraulic circuit operating a clutch

(57) A damping device is connected in a pressure line between a clutch slave cylinder and a clutch master cylinder and comprises a single or two piece housing 1a containing a sealed piston 13 biassed by a coil or plate spring 12. Vibrations transmitted from an internal combustion engine to the hydraulic circuit are damped by the piston 13 moving against the spring 12 so as to expand the volume in the housing 1a. The plate springs 12 may be arranged in alternate directions and/or the same direction so as to influence the damping characteristics of the device. In the two piece housing there is a socket part (22a, fig 2), which may contain a throttle valve, and a push-in part (23a) that engage with each other by means of a keyed connection held together by a sleeve (24a). The piston in the one piece housing 1a is contained in a section that is off-set relative to an inlet and outlet. Many other embodiments are disclosed including damping devices that use membranes that flex to accommodate the vibrations.

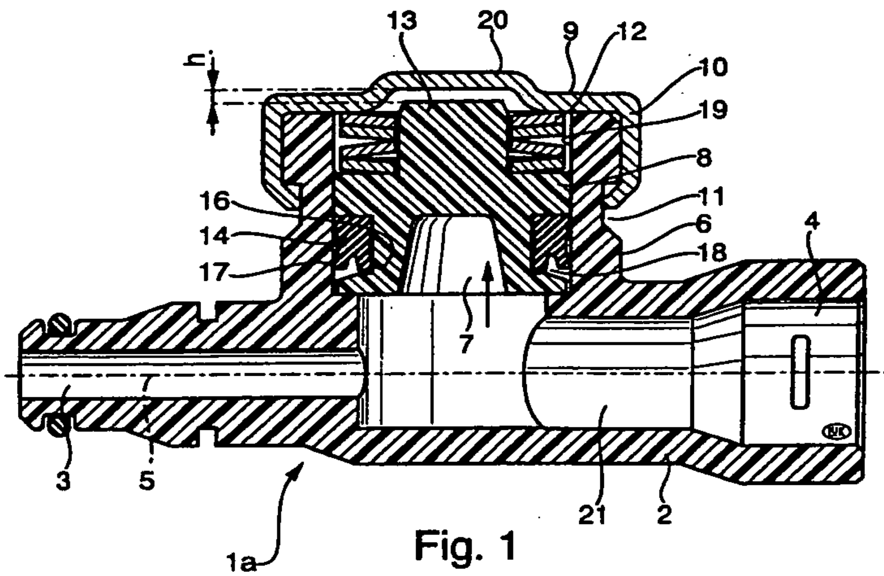
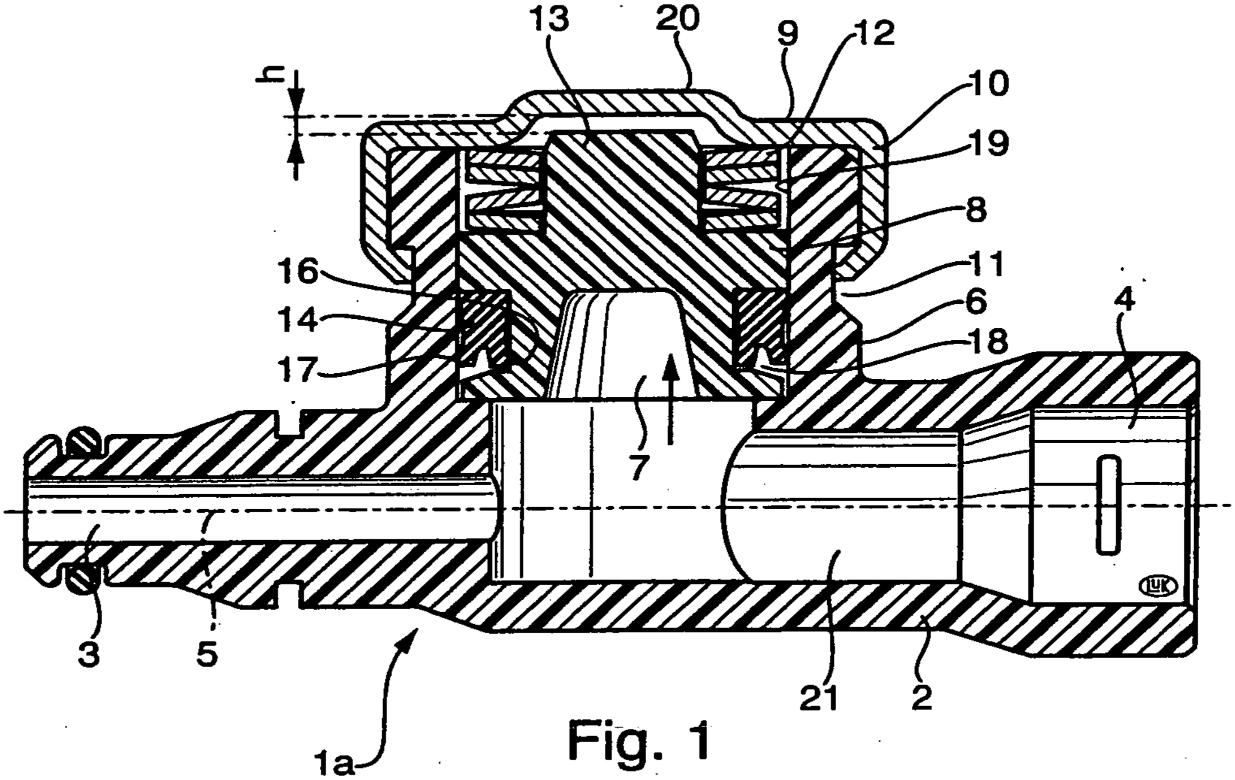


Fig. 1

GB 2 348 259 A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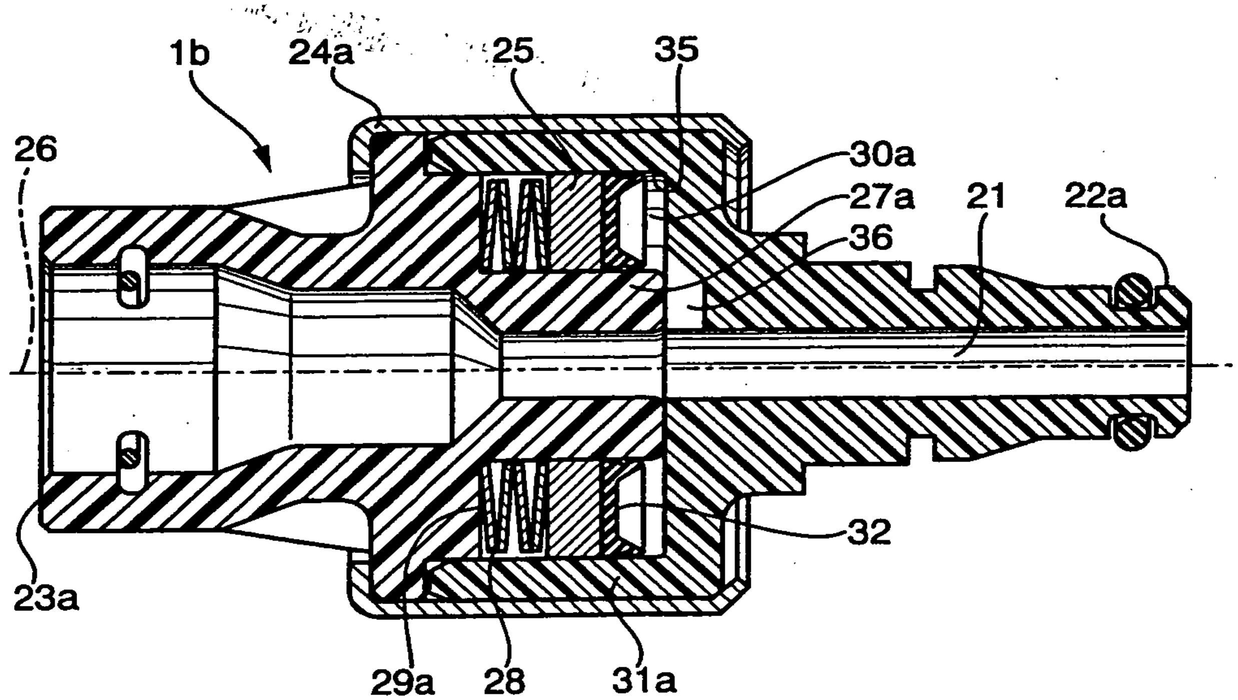
1a

Fig. 1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22a
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23a
29a
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31a

Fig. 2

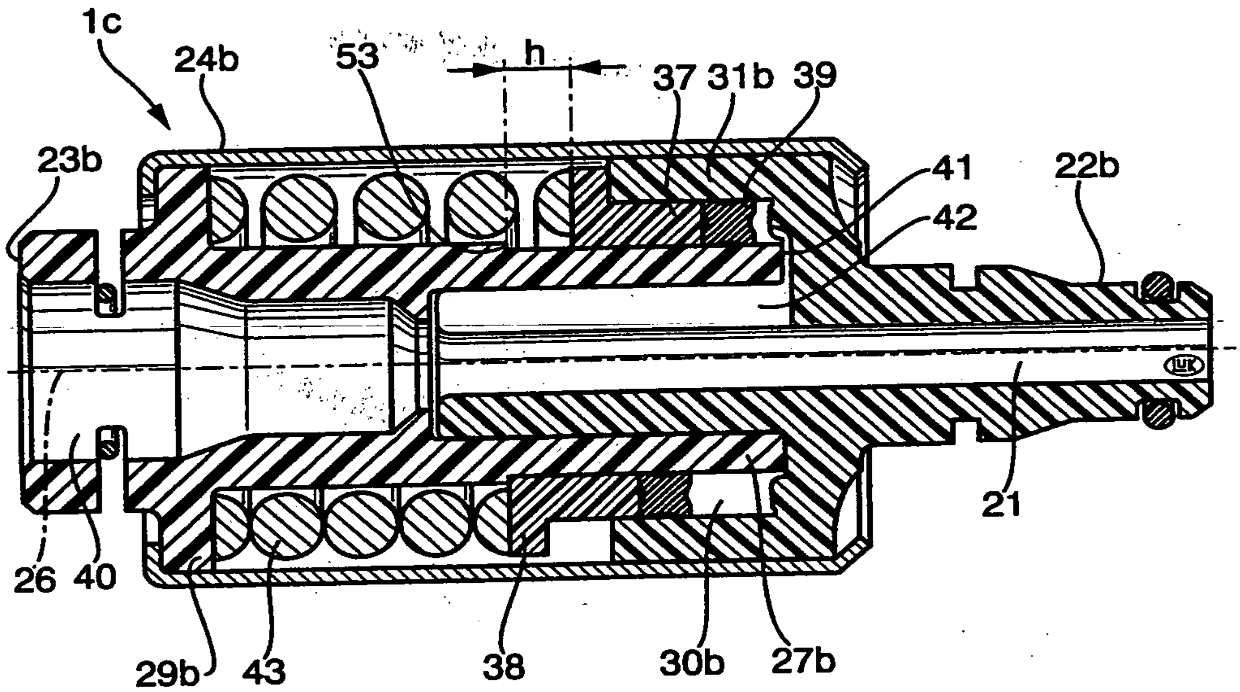

Fig. 3

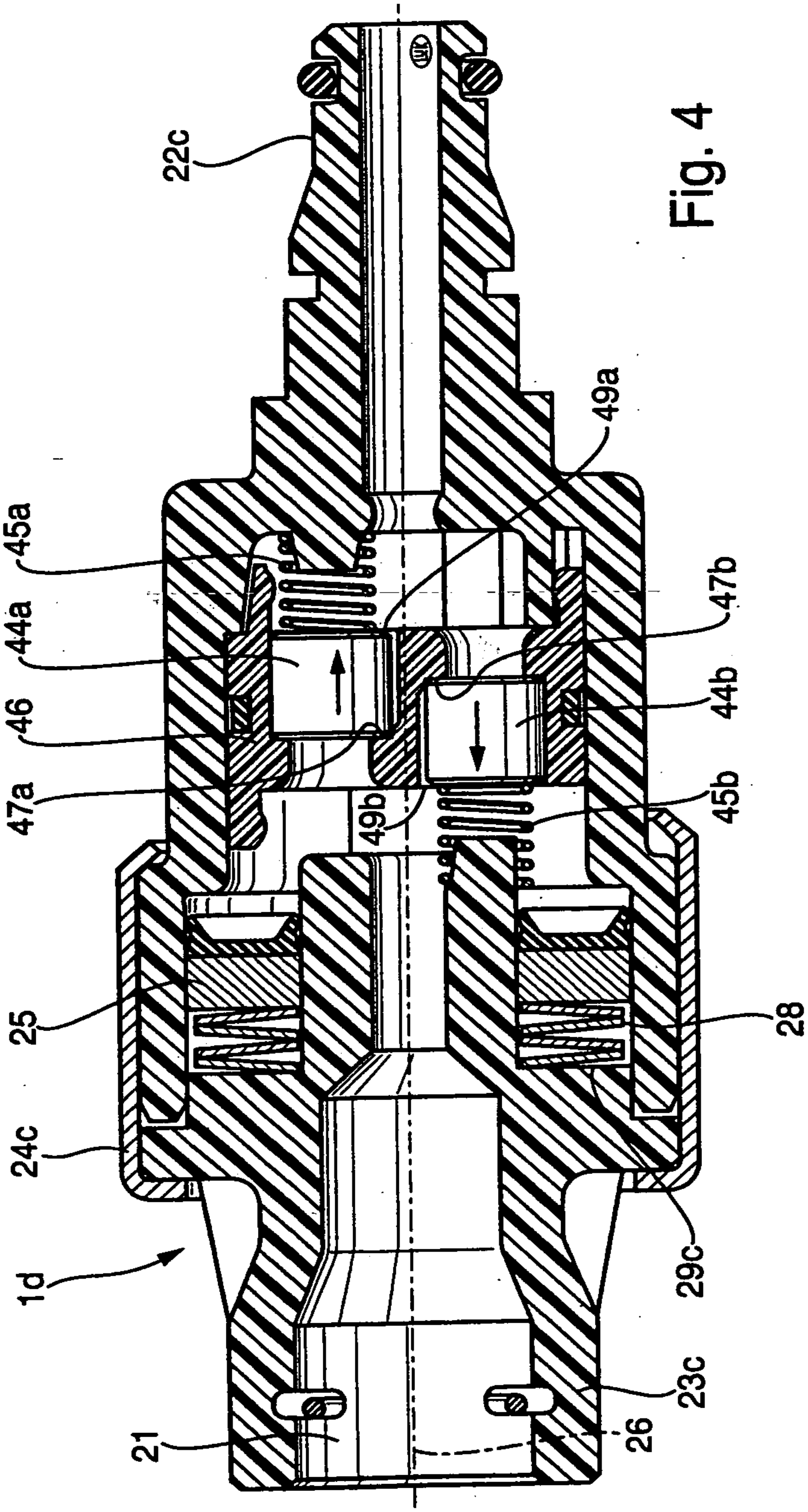

Fig. 4

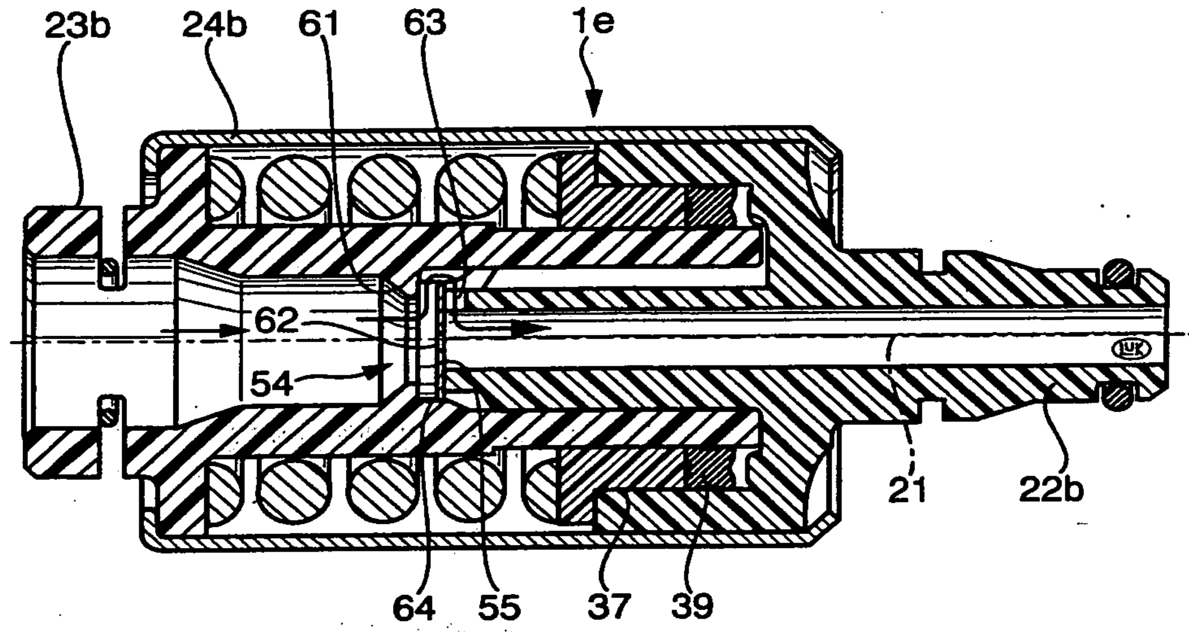

Fig. 5

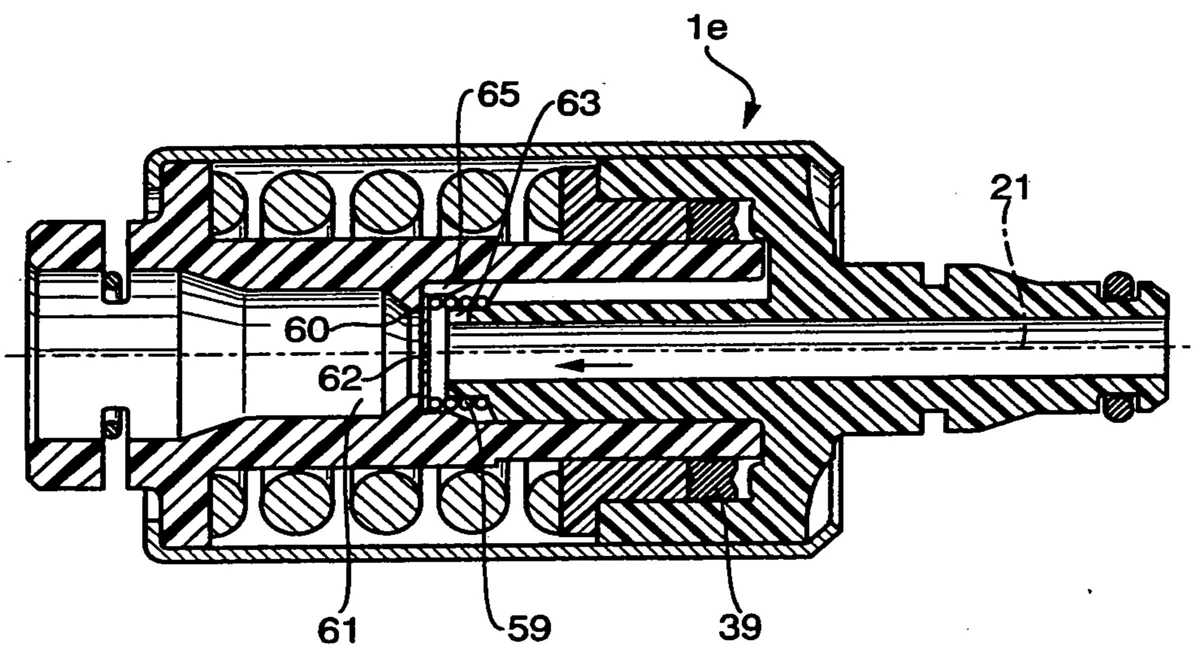

Fig. 6

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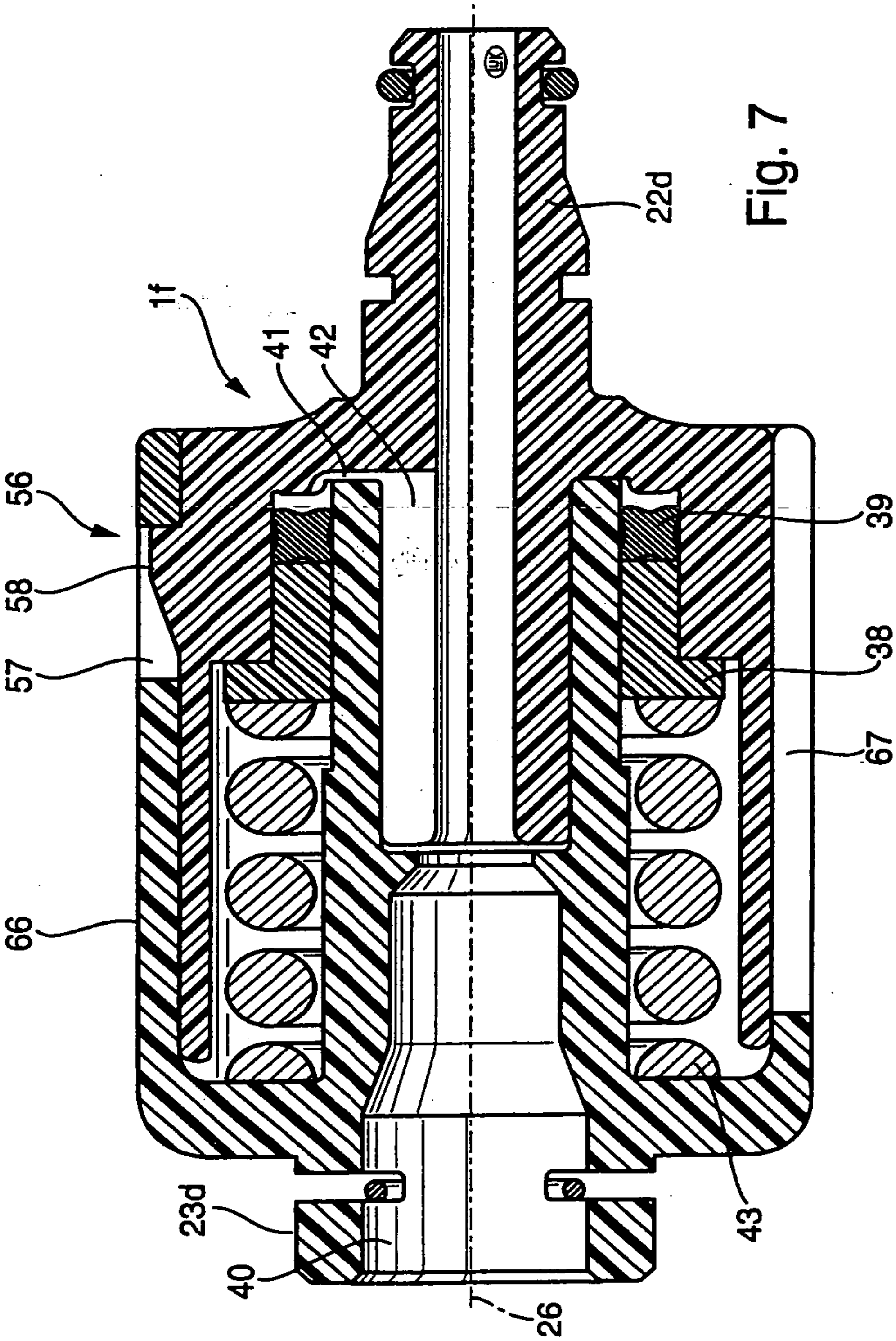


Fig. 7

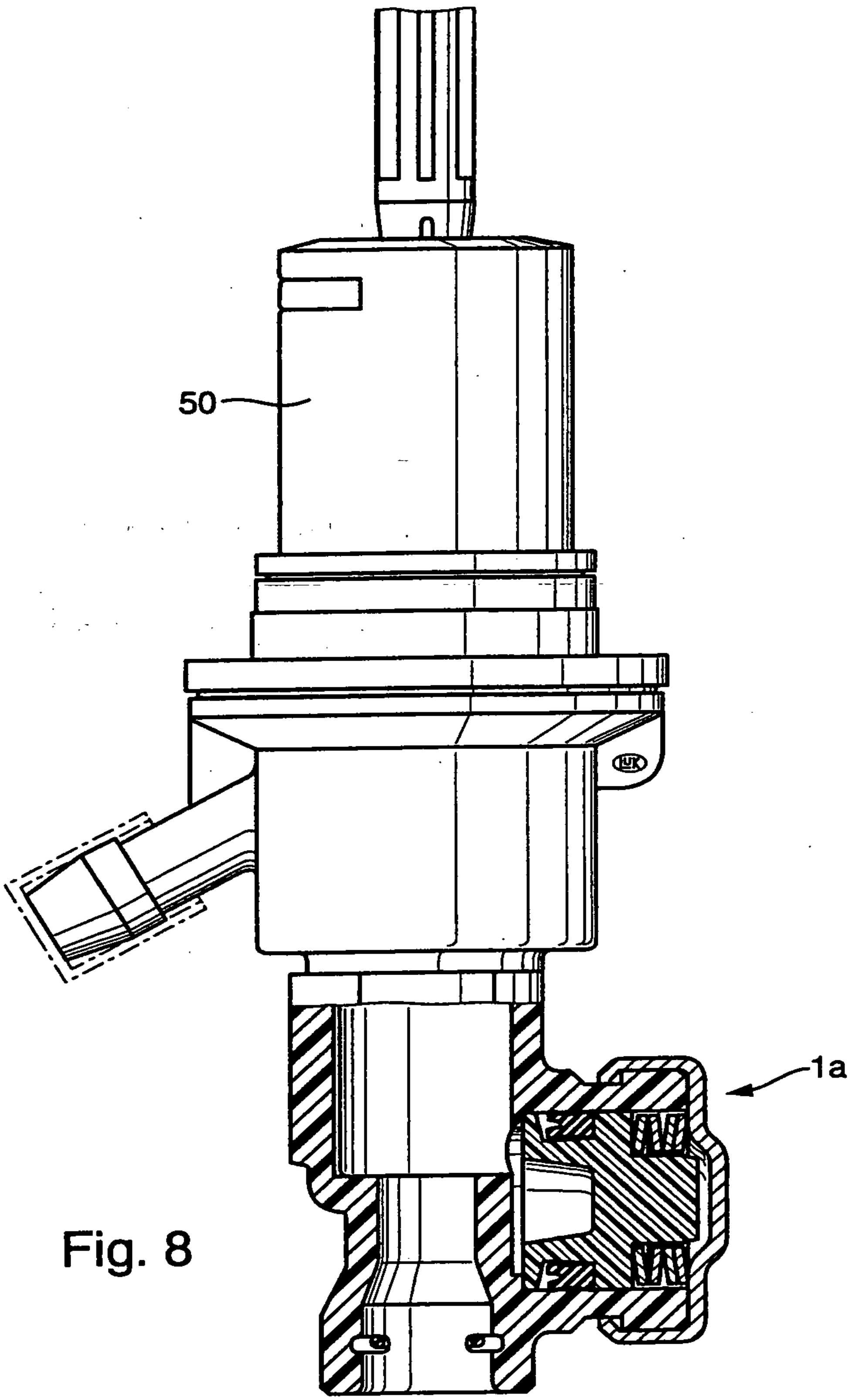


Fig. 8

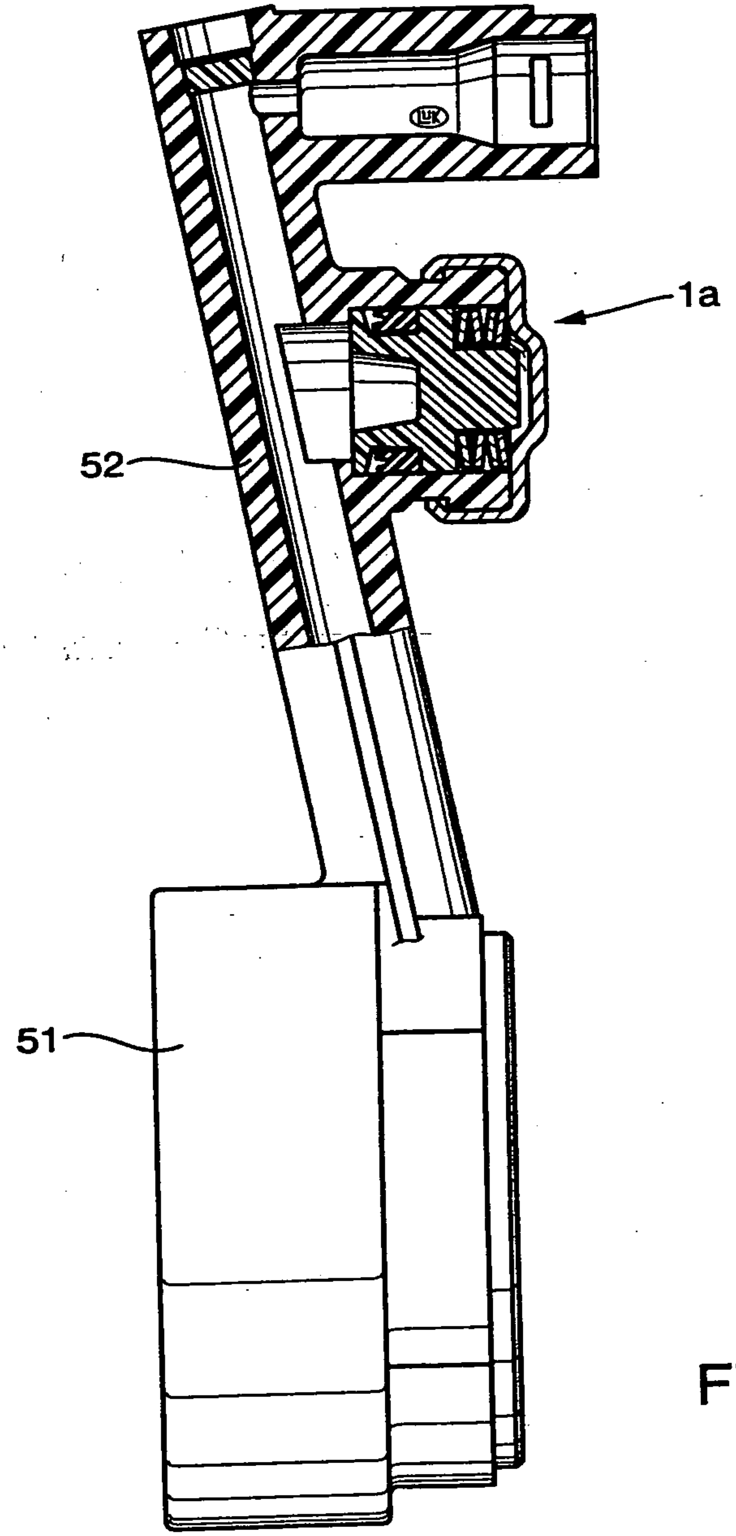
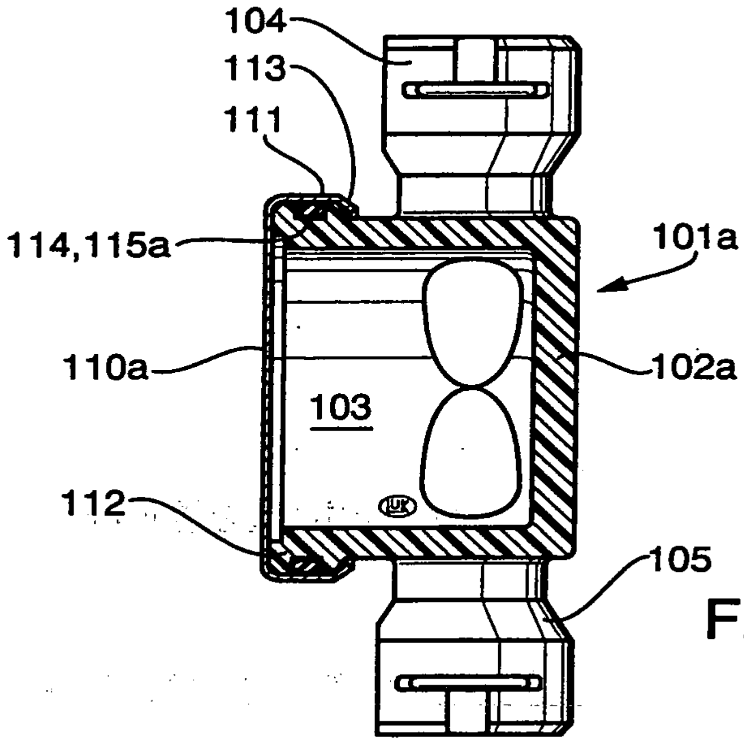


Fig. 9



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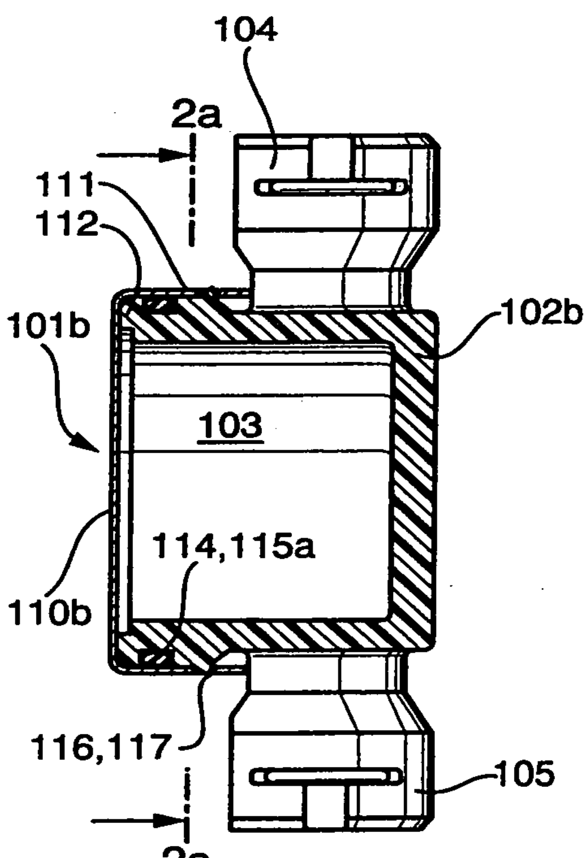


Fig. 11

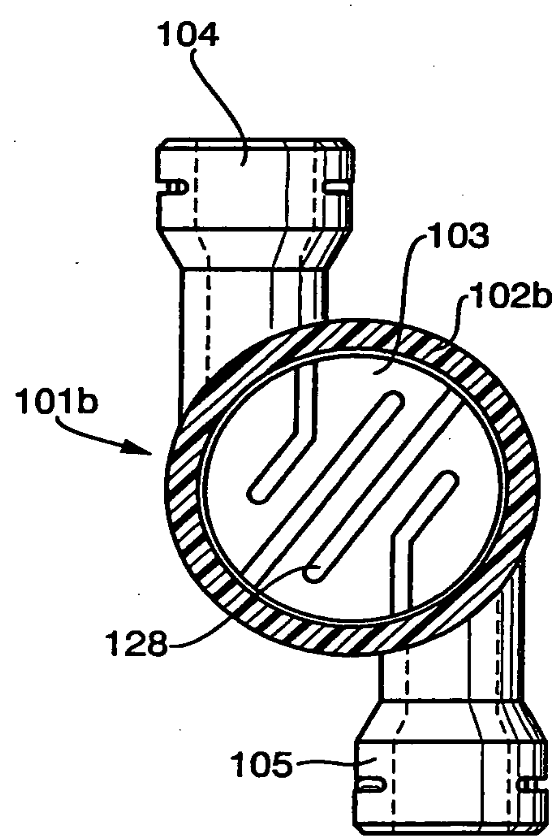
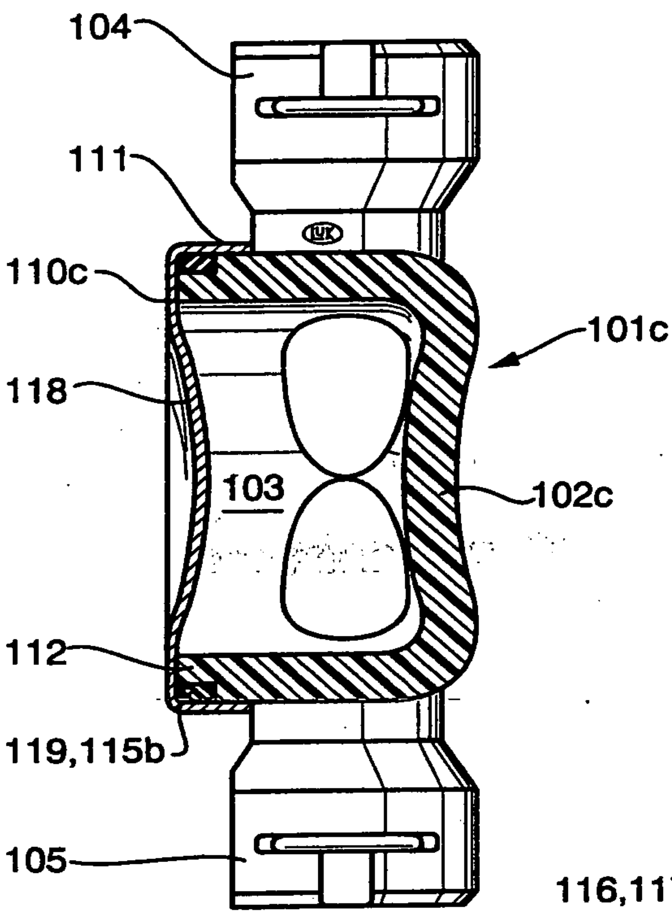


Fig. 11a



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101c
118
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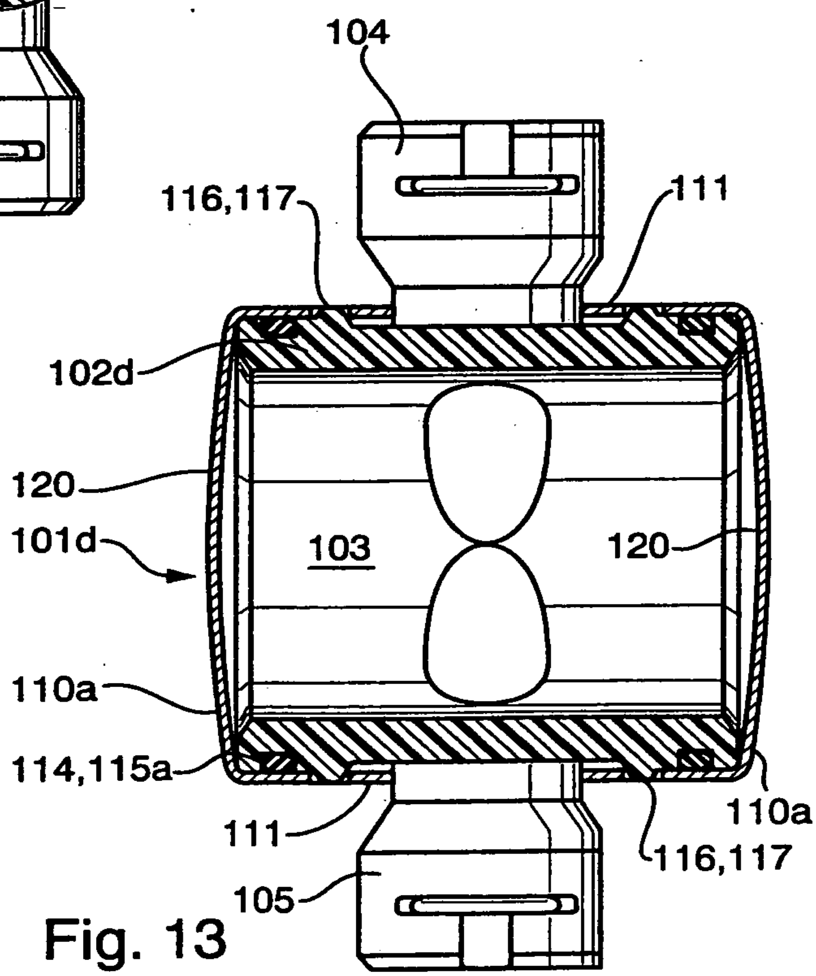
102c
112
119,115b
105

Fig. 12



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116,117
105

Fig. 13

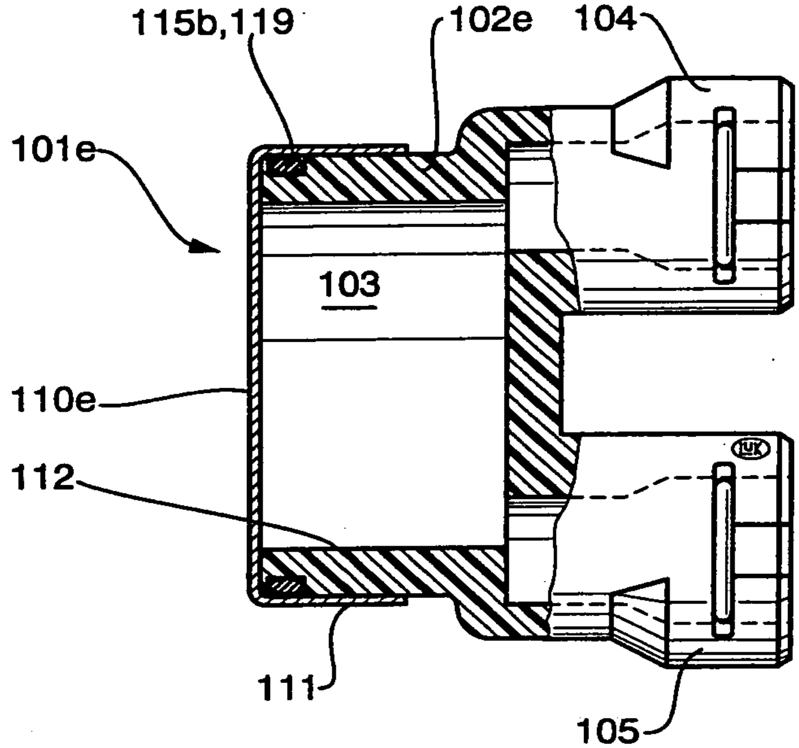
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Fig. 14

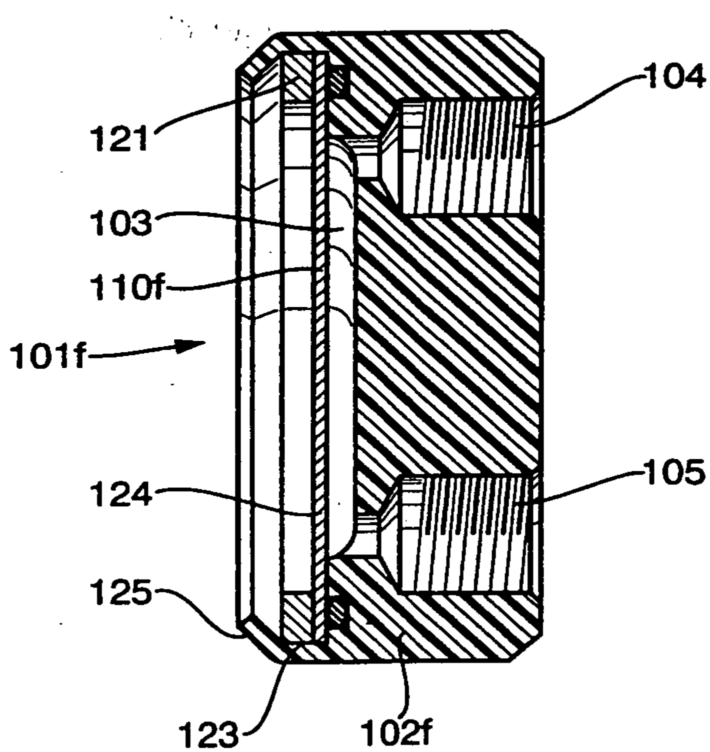
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Fig. 15

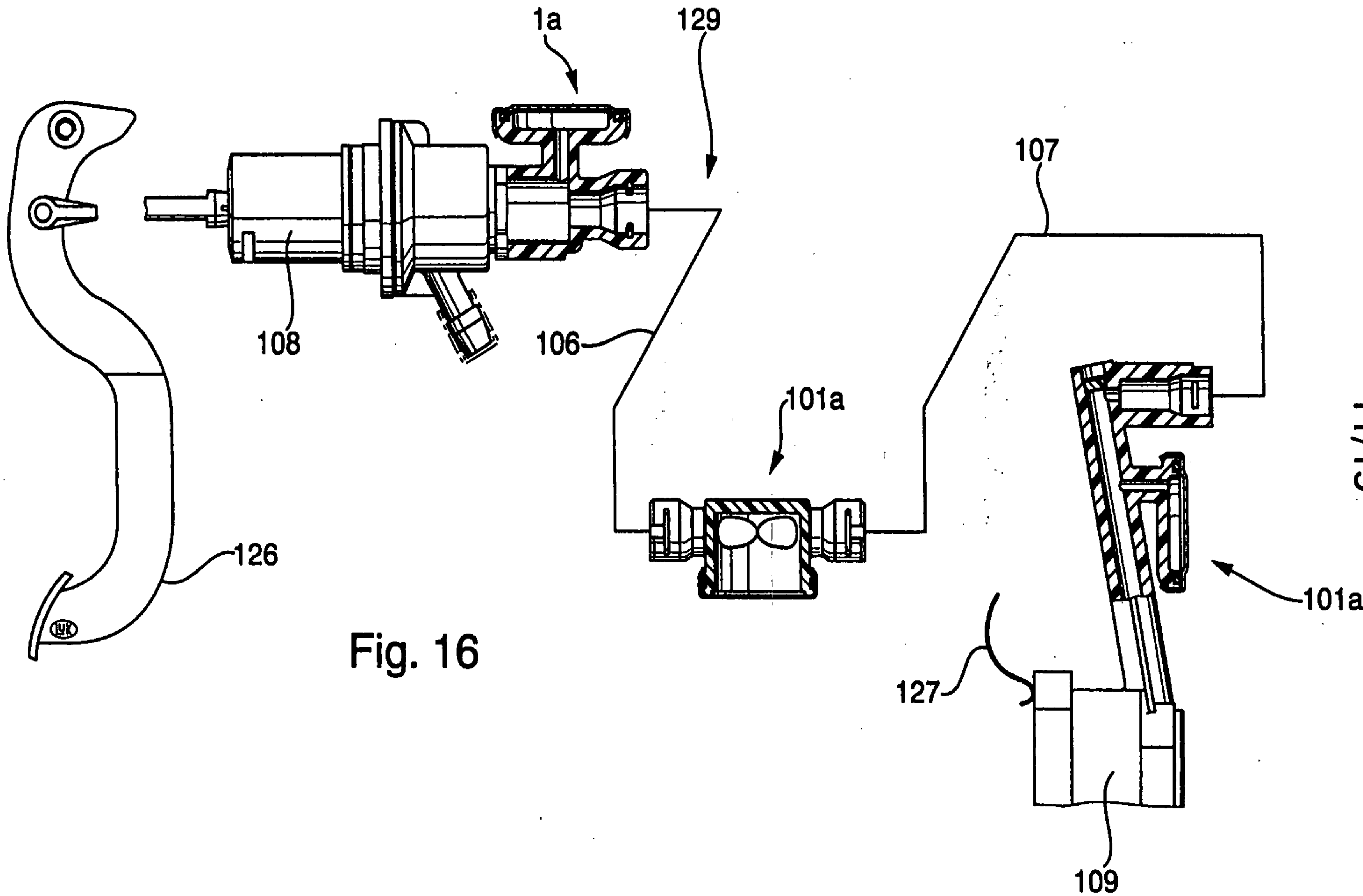

Fig. 16

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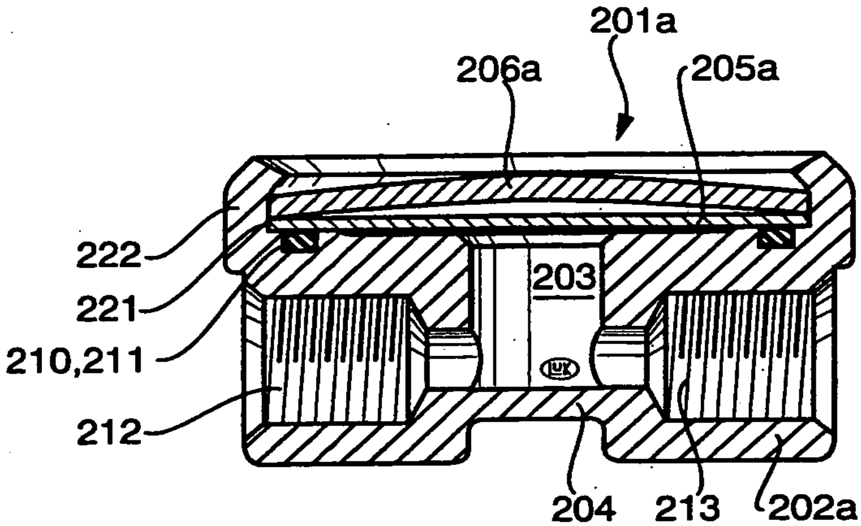

Fig. 17

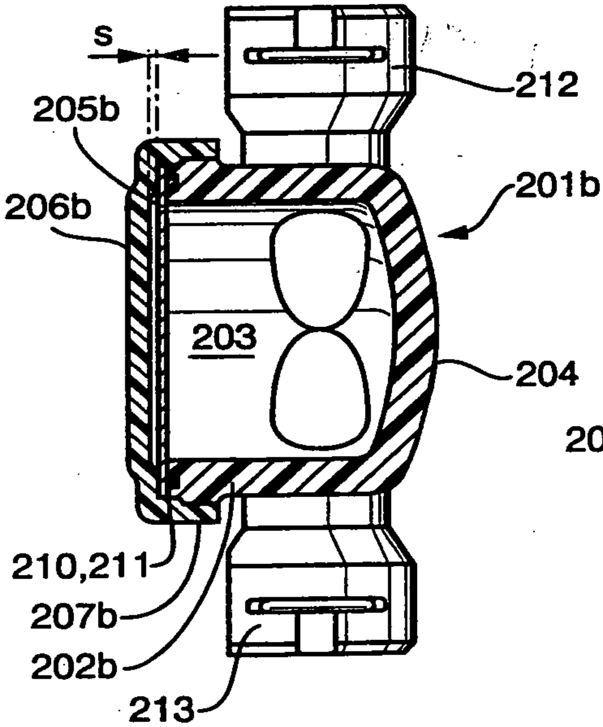

Fig. 18

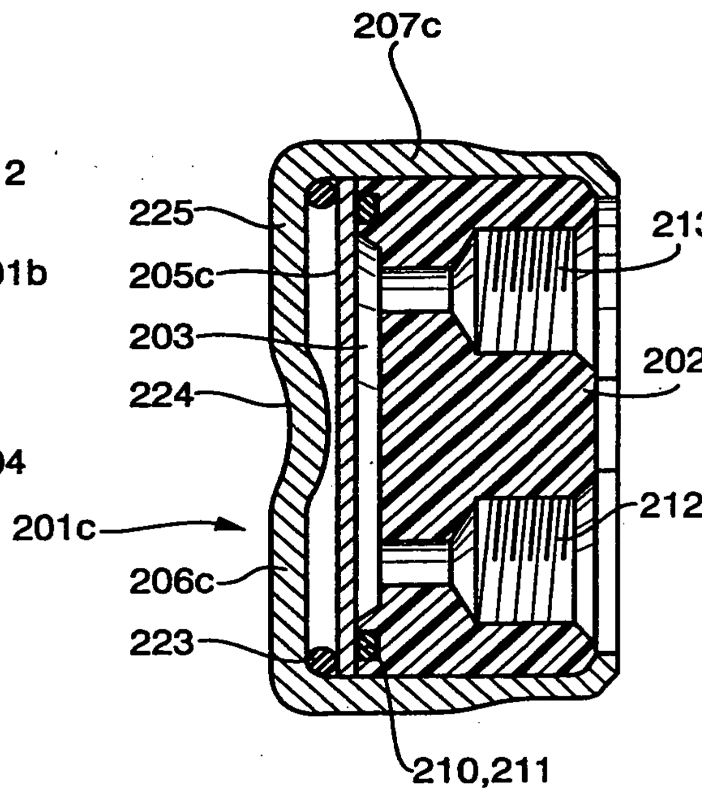

Fig. 19

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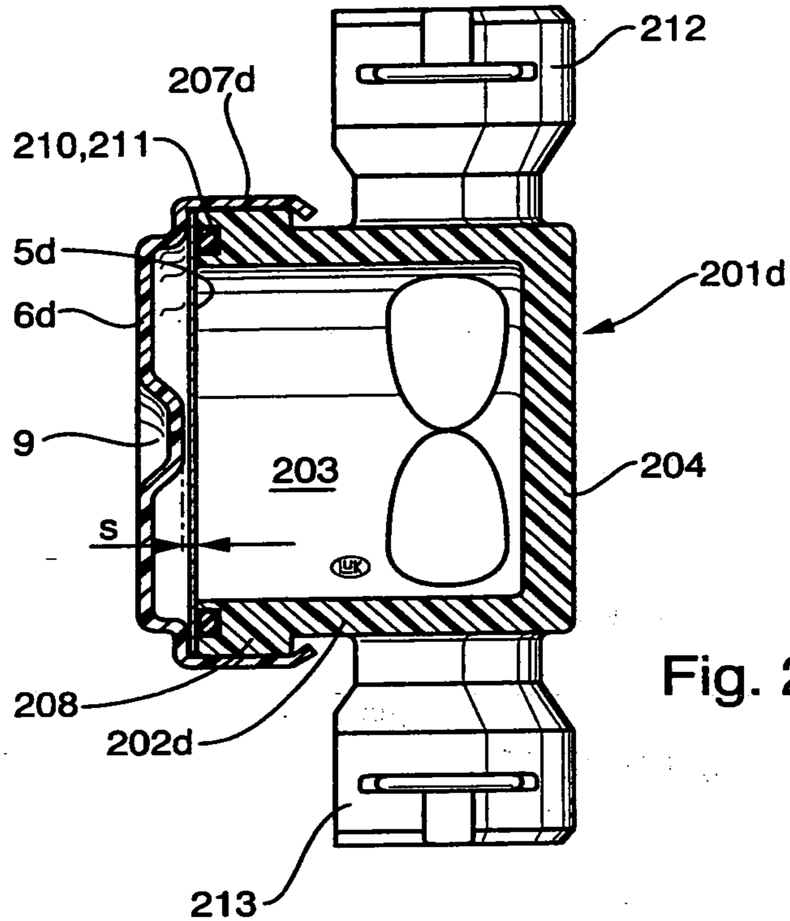
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202d
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Fig. 20

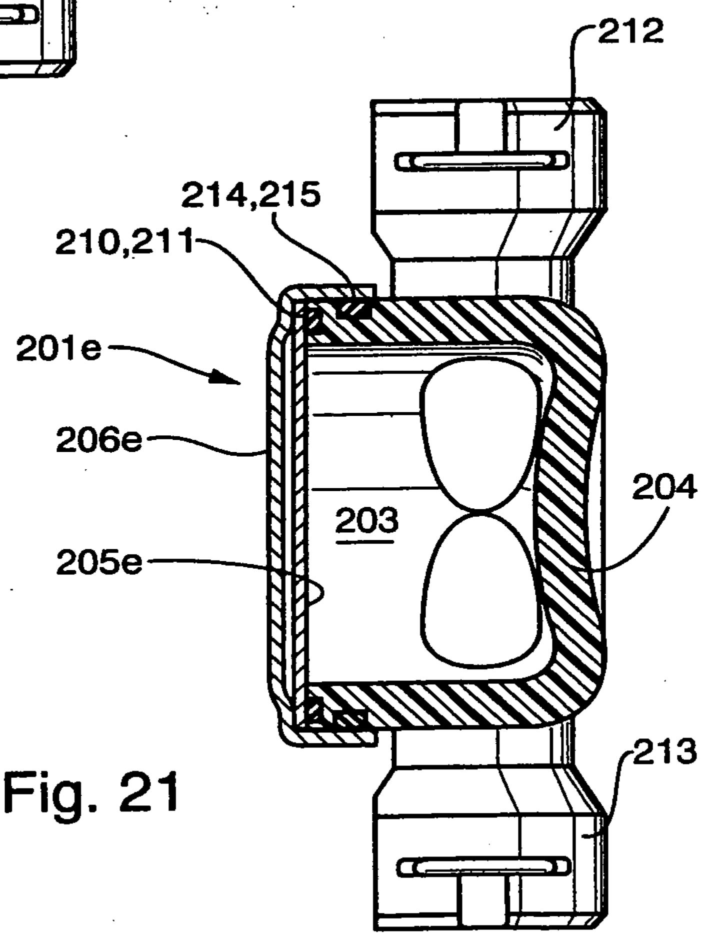
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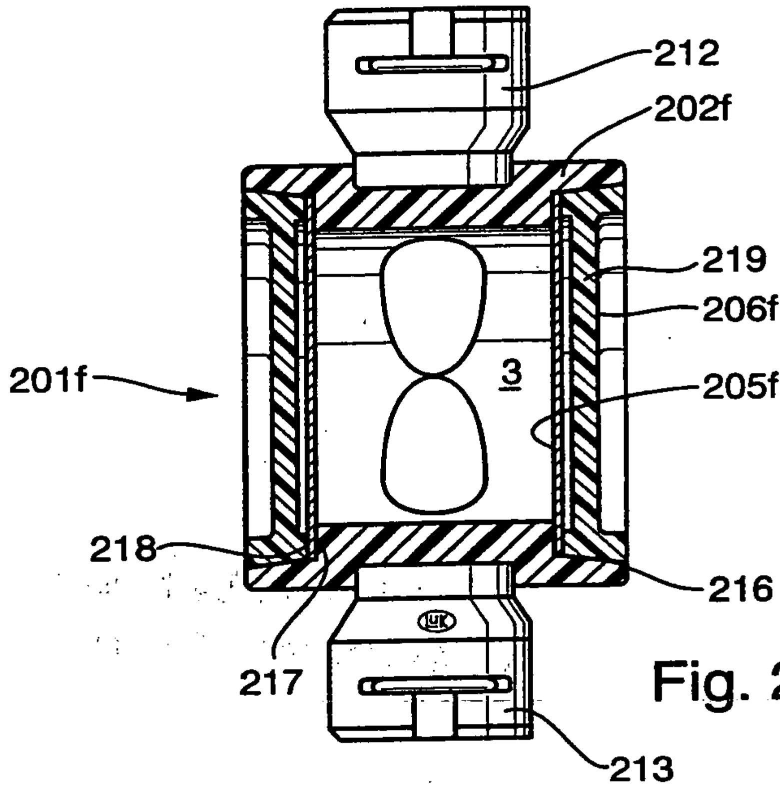
Fig. 21



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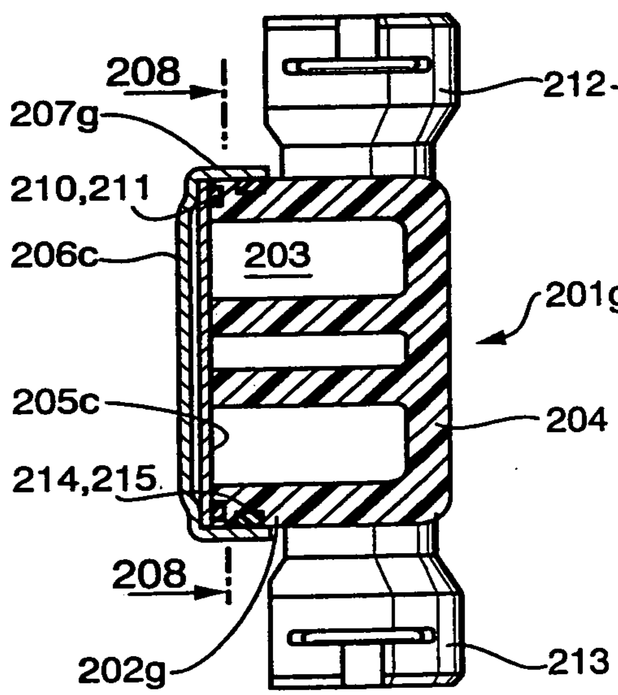

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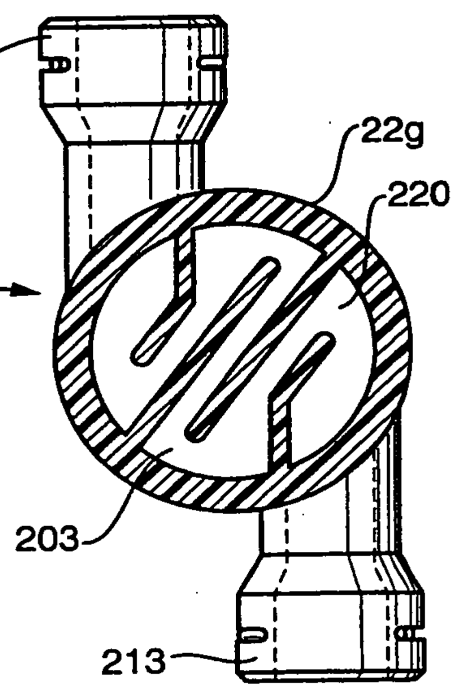

Fig. 24

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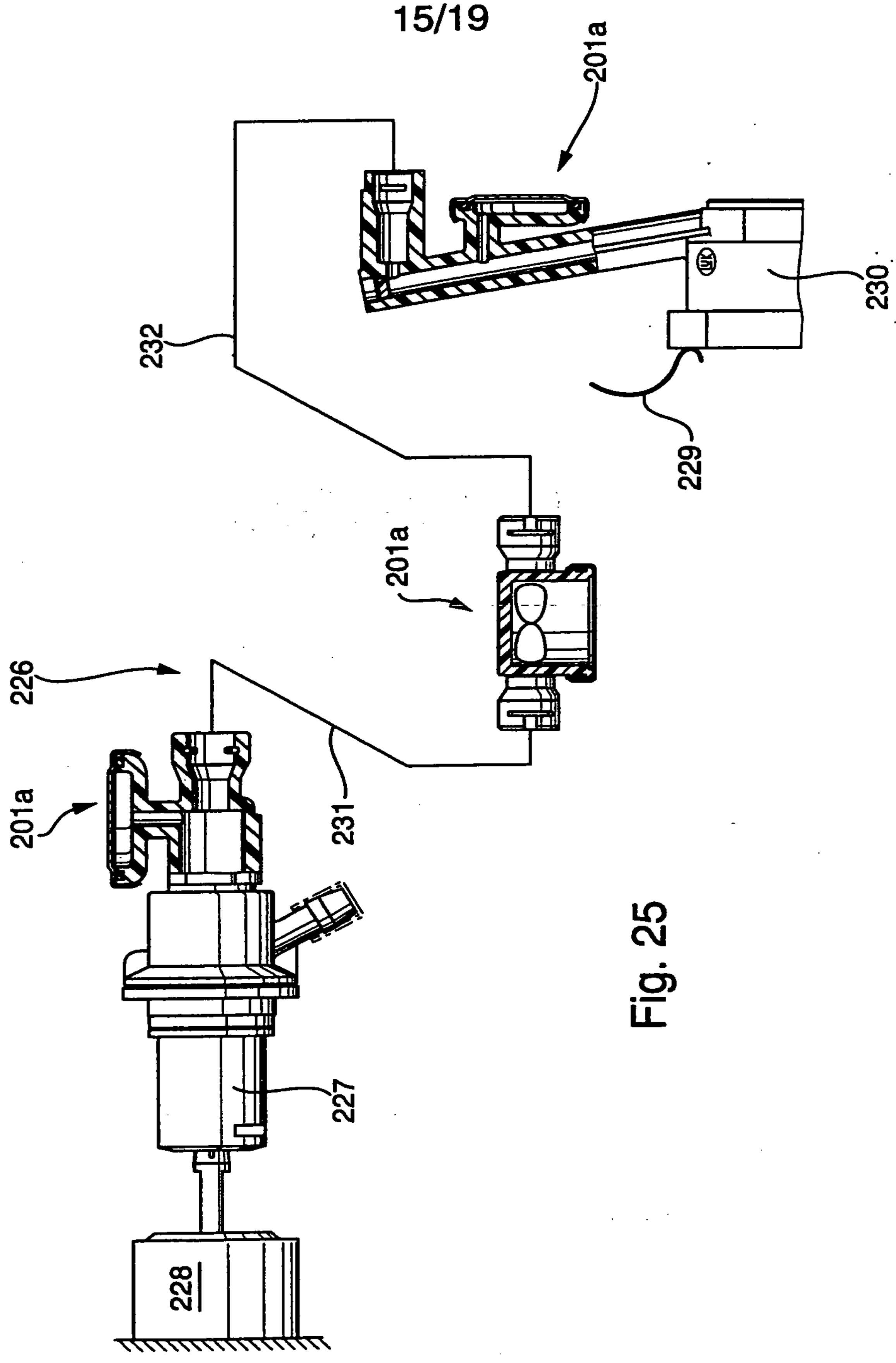

Fig. 25

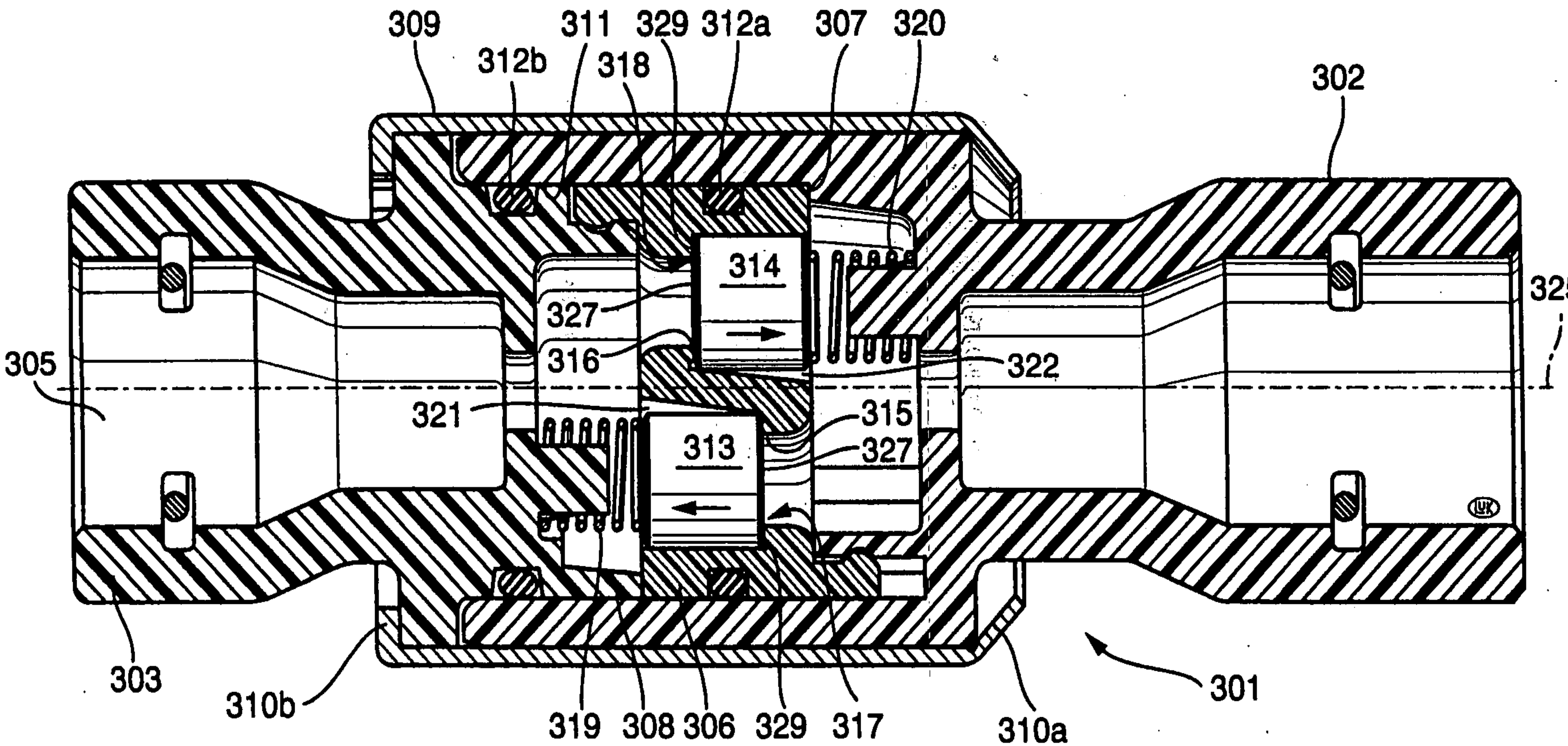
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Fig. 26

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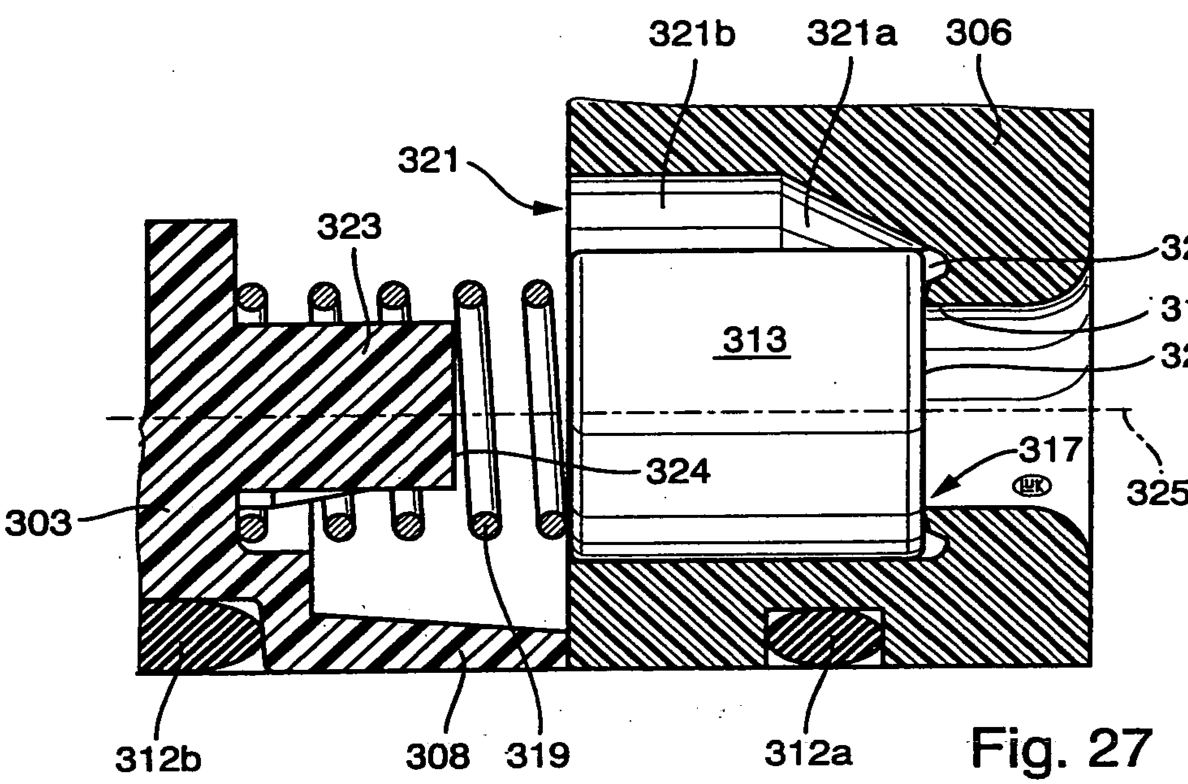
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Fig. 27

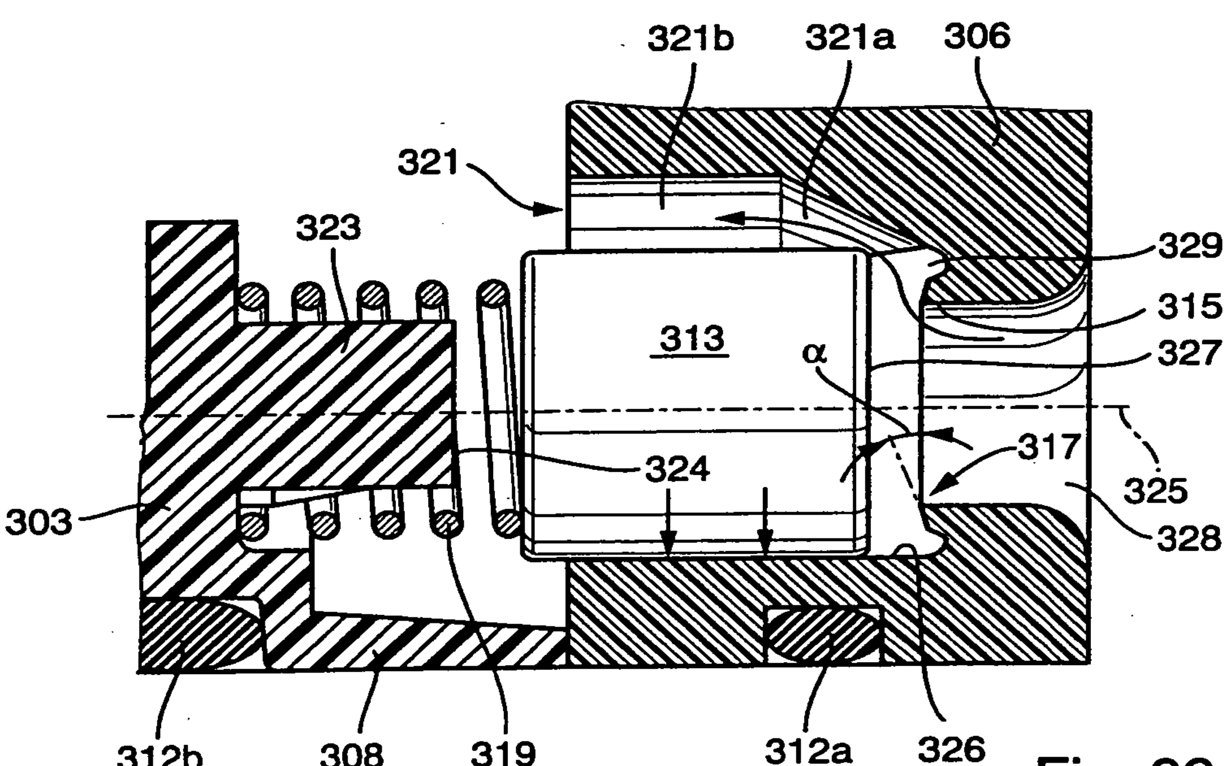
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Fig. 28

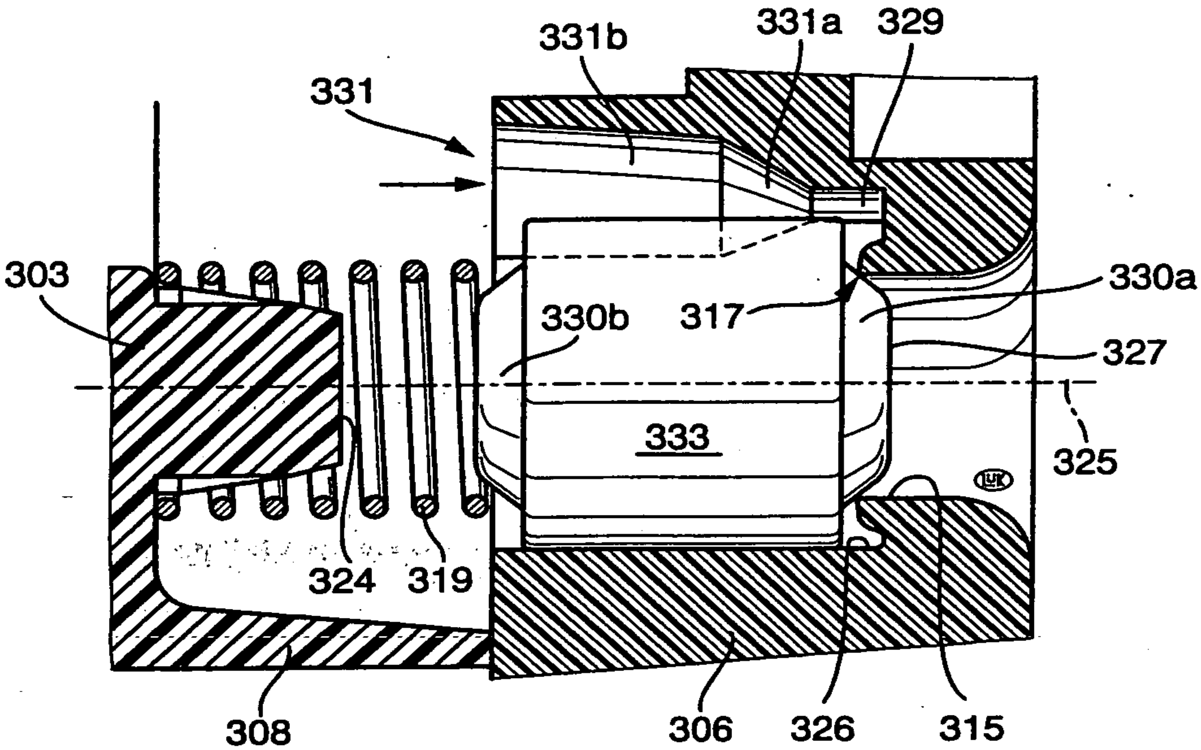
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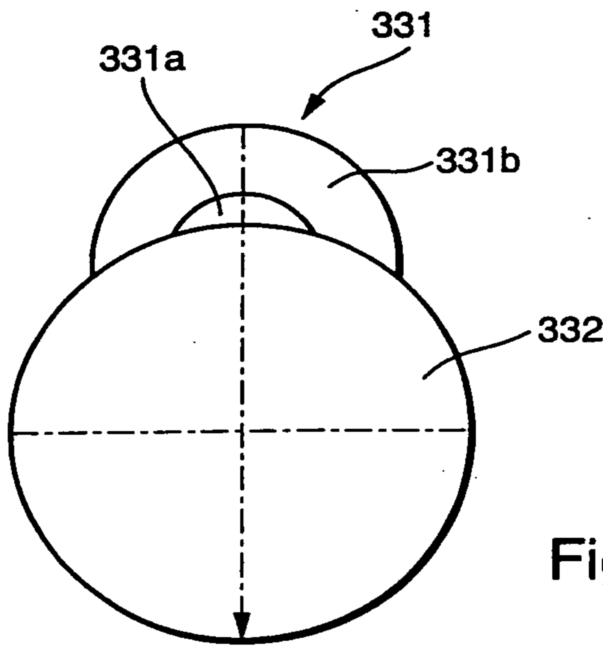
Fig. 29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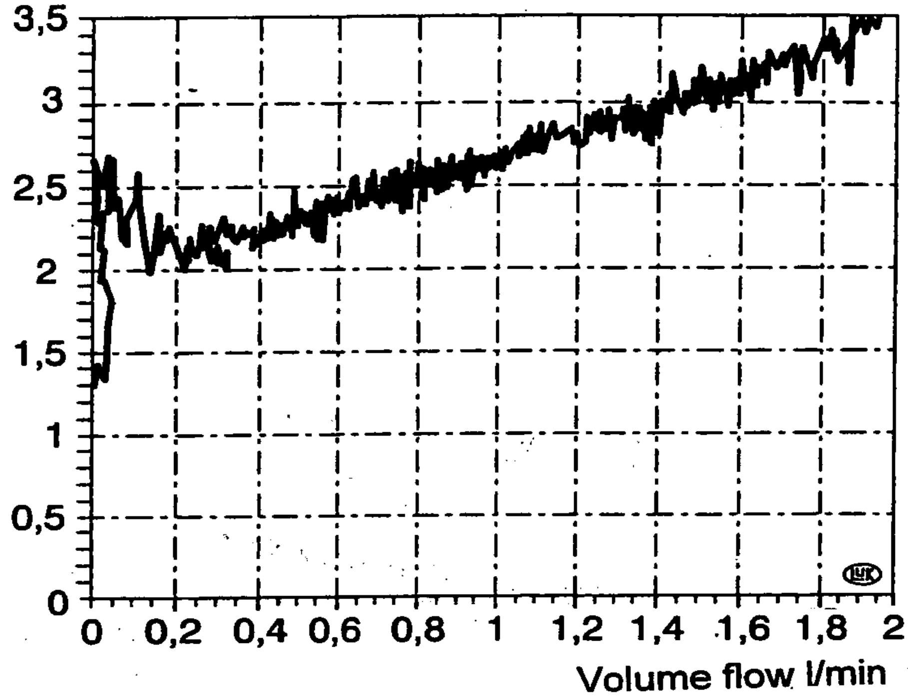
331a
331b
332

Fig. 30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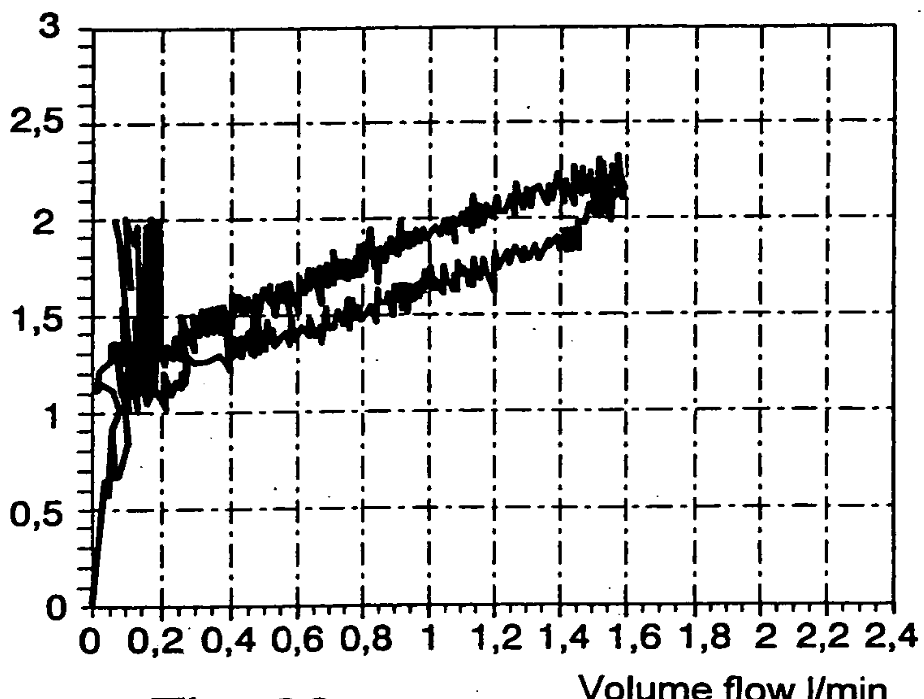
2
Volume flow l/min

Fig. 31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0
0,2
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2
2,2
2,4
Volume flow l/min

Fig. 32

2348259

Damping device in a hydraulic operating system of a shift and separate clutch

The present invention relates to a device for damping pressure vibrations in hydraulic systems. Damping devices of this kind are used for example for the hydraulic activation of a shift and separate clutch for vehicles. The operating system comprises a master cylinder which can be activated by a manually operated clutch pedal and which is connected by a pressure line to a slave cylinder which is mounted on the shift and separate clutch. The pressure line contains a damping member whose housing has a membrane which can be biased by pressurised fluid.

Furthermore the damping device which is integrated in the operating system or is connected thereto can be provided with a housing which comprises a free-swinging membrane as well as a security element which forms a lift restriction for the membrane in the event of unacceptably high pressure vibrations or pressure pulsations.

Hydraulic systems which are used in vehicles for operating a shift and separate clutch which can also advantageously be automatically self-adjusting, require damping devices to dampen the pressure vibrations which are transmitted from the internal combustion engine into the operating system. The construction of the operating system comprises a slave cylinder which is connected through a pressure line to a master cylinder and acts on a release bearing of the shift and separate clutch, with a clutch pedal which is to be operated manually interacting directly with the master cylinder or with the master cylinder being operated for a

example automatically by means of an electric motor and preferably controlled by a control unit. The damping device can therefore be integrated in a component part of the operating system or can be connected to one of these component parts. The invention relates to the design of the damping device, whose housing is provided with a cylindrical installation chamber or hollow chamber in which a sealed body is inserted which can be displaced in the event of pressure vibrations occurring.

From FR 2 762 662 A1 a damping device of the generic type is known which can preferably be integrated in the pressure line of the hydraulic operating system. The known damping device comprises a housing with a hollow cavity adjoined off-set in the flow direction by a recess or free area to hold an elastically deformable body. The body which is made of plastics is inserted sealed in the damping device and is provided on the side remote from the installation chamber with a stop. The elastic material of the known damping device does not allow any defined damping characteristic so that the efficiency or conformity to a specific type of vehicle is difficult. Furthermore the damping material is to be designed to take into account a resistance to the pressurised fluid, a brake fluid or clutch fluid, used in the hydraulic operating system.

Furthermore the combustion process of an internal combustion engine triggers axial vibrations which appear to different degrees depending on the number of cylinders of the internal combustion engine and the combustion process. The axial vibrations are transferred from the crankshaft through the friction clutch or clutch spring to the release bearing and the

slave cylinder. From there the axial vibrations continue into the entire hydraulic release system and cause pressure pulsations which can lead to unacceptable tingling in the clutch pedal which represents a severe loss of comfort.

Owing to the slight amount of friction in a hydraulic release system the transfer of the pressure pulsations is more intensive than in the case of mechanical release systems.

In order to avoid pressure pulsations it is known to insert hydraulic throttles or diaphragms into the hydraulic line in order to increase the flow resistance so that sufficient resistance opposes the axial vibrations. However this measure has a detrimental effect on the degree of efficiency of the hydraulic system. This drawback is due to a volume displacement triggered by the axial vibration of the crankshaft and causing a significantly lower flow speed in the pressure lines than the flow speed which occurs during engagement and disengagement of the hydraulic system.

From DE A 29 38 799 a hydraulic damping device is known which is attached to a pressurised medium line between the master and slave cylinder. The construction comprises a piston inserted displaceable in the housing of the damping device and on one side loaded by pressurised medium and on the other side adjoining a power spring. This known damping device corresponds to an expansion element which is inserted in the pressure line and which is to take up the volume displaced by vibrations or pressure impulses through displacement of the piston and is to discharge same in the event of a drop in pressure. This measure is to prevent the

vibration from reaching right up to the master cylinder or up to the clutch pedal. Apart from an only moderate damping action, the degree of efficiency of the hydraulic release system is impaired by such a measure since this also takes up during the coupling process as a spring-acting damping member volumes of the pressurised medium corresponding to the relevant pressure increase.

GB A 22 46 819 likewise shows a damping device for a hydraulic activation of shift and separate clutches. This known damping device comprises two free-swinging membranes integrated in a housing for compensating the pressure vibrations which appear. For position fixing, each membrane is fixed on the housing by a cover. The pot-shaped cover thereby completely encloses the membrane. A circumferential edge of the cover is angled inwards at the ends and engages behind a projection of the housing. The damping device which is made from a metal material has a high inherent weight and requires expensive membrane fixing.

With hydraulic operating systems for shift and separate clutches there is furthermore often the problem that the vibrations triggered by the combustion process of an internal combustion engine are transmitted through the crankshaft as axial vibrations to the clutch pressure plate and to the release mechanism of the shift and separate clutch and thus to the slave cylinder which is connected thereto. These vibrations cause the clutch pedal to vibrate which is perceived by the driver when he operates the pedal to release the shift and separate clutch, or adversely affect an actuator for the master cylinder when an actuator is used instead of a clutch pedal. The axial vibrations

are thereby transferred from the slave cylinder through the fluid column in the pressure line as pressure pulsations to the master cylinder and thus to the clutch pedal.

In order to compensate these disadvantageous pressure pulsations it is known to form the pressure line in part as a hose. The elastic properties of the hose are to eliminate or dampen the pressure pulsations occurring in the hydraulic system between the master and slave cylinders. This known measure impairs the degree of efficiency of the hydraulic operating system since this damping member also takes up volumes of the pressurised medium accordingly during the clutch process and the rise in pressure associated therewith.

GB A 22 46 819 shows a further damping device for a hydraulic operating system for a shift and separate clutch. This known damping device comprises two membranes integrated in a housing and arranged opposite one another for compensating the pressure vibrations which appear. For position fixing, each membrane is fixed on the housing by a pot-shaped cover which encloses the membrane. A circumferential edge of the cover is angled inwards at the ends and engages behind a shoulder of the housing. The damping device which encloses the membrane is thereby mounted relatively far apart axially from the membrane. This cover therefore offers no protection against overload and no lift restriction for the membrane which in the event of strong pressure pulsation leads to a high vibration amplitude.

A damping device of the generic kind is provided in US A 5 070 983. The membrane of this device is supported

at the end side on a housing and is enclosed by a pot-shaped security element which with one edge surrounds a cylindrical end area of the housing and engages at the end behind a shoulder of the housing. The security element is spaced axially from the membrane and has in the centre area of the membrane a protruding shoulder which forms a stop or a lift restriction for the membrane. The construction of this known device comprises, with the exception of the membrane, component parts which are designed as cast parts with a high inherent weight. As a result of this inherent weight the known damping device requires a suitably adapted secure fastening which increases the necessary assembly expense and the costs connected therewith.

Taking into account the drawbacks of the known solution the object of the present invention is to produce a sturdy damping device which can be manufactured cost-effectively and which has a defined damping characteristic.

Starting from further known solutions it is a further object of the present invention to provide a damping device which in addition to a high damping characteristic has a reduced number of component parts. Furthermore the damping device is to be optimized with regard to weight.

The object of the present invention is also to produce a damping device which has both a high damping property and security against unacceptable pressure pulsations.

The invention is solved more particularly through a damping device which is connected to the pressurised medium and which is set in a housing which can be

expanded in terms of its volume against the action of an energy accumulator. This housing can be a separate housing for the damping device or the housing of another component part, such as for example of the master or slave cylinder. The expansion of the volume can advantageously be brought about by means of a component part such as a ram which is sealed from the housing and which can be displaced in a suitable recess in the housing against the action of the energy accumulator, such as a spring, a resilient plastics element or the like. Furthermore it can be advantageous to displace two housing parts relative to each other. The force constant, such as for example the spring constant of one or more plate springs and/or coil springs, of the energy accumulator can thereby be attuned linearly or non-linearly, for example progressively or degressively, so that the force which is applied by the energy accumulator to the sealed component part creating the increase in volume does not linearly depend on its path. Therefore in the proposed pressure region of the damping device the stiffness can be very small and outside of the pressure region can be set clearly raised, for example to avoid path losses of the sealed component part relative to the working region. Through the choice of force constant it is therefore possible where the geometry and design of component parts are otherwise substantially the same, to match the damping device to the relevant case of use, whereby advantageously only one damping device - each only with a modified energy accumulator - need be kept for various different uses.

According to the invention the problem outlined above is further solved through a closure body mounted sealed in a hollow cavity of the housing and supported on a

spring element. The spring element is preferably arranged so that this does not exceed the outer contour of the closure body in order to thereby ensure an optimum space-saving arrangement. The spring element is preferably separated through the sealed closure body which has a positive effect on the method of operation of the damping device, i.e. the spring element is thus independent of the effects of the pressurised fluid. The invention allows the use of spring elements of various structural shapes, which are preferably made from metal materials or alternatively from elastomer. Furthermore the invention includes spring elements having different spring constants which can be inserted in the installation space provided. A simple flexible adaptation or designation of the damping characteristic for different hydraulic operating systems can thus be produced with less expense. At the same time there is a cost advantage since the damping device which is designed for different pressures or stiffness has the same construction except for the spring element.

The invention allows the damping characteristic or damping action to be easily influenced through the interaction of the geometric design of the closure body with the design of the spring element, i.e. the spring constant or spring stiffness of the spring element and the surface area of the closure body which is loaded with pressure.

According to an advantageous design a piston is provided as the closure body which on the pressure chamber side seals the pressure chamber by way of example with a piston ring type sealing ring.

A plate spring is preferably used as the spring element on which the piston or closure body is supported. The plate spring which can be produced cost-effectively in space-saving manner is thereby inserted into the installation chamber of the housing and is thus supported on the end side of the piston. The structural space required for the plate spring is reduced by using a perforated plate spring which is centred on a shoulder of the piston pointing towards the installation chamber and which is mutually supported on the base of the installation chamber.

The invention further includes a closure body designed as a piston and supported on a spring element formed as a coil spring. A spring member of this kind allows in a special way a desired soft spring constant so that an effective damping characteristic can be achieved for a hydraulic operating system. The coil spring thereby has at least two windings.

The invention further allows the use of several plate springs which can be combined into a plate spring parcel. The individual plate springs can thereby be layered in alternating directions or in the same direction so that the stiffness and thus the characteristic of the damping device can be influenced dependent on the number of plate springs.

The plate springs are characterised by an economical space-saving cost-effective design which can preferably be combined with the weight and space-saving piston of the damping device.

A further design of the invention proposes mounting the installation chamber for holding the closure body or

piston in a section of the one-piece housing which (section) is off-set or remote from the flow direction. An installation chamber preferably aligned at right angles to the through-flow direction makes it possible to use a fully cylindrical piston whose seal adjoins the inner wall of the installation chamber by a dynamic sealing lip. A piston seal of this kind has a high seal protection.

The installation chamber in which the closure body or piston is elastically or resiliently inserted is advantageously closed by a cover. The cover is thereby designed and shaped so that after installation of the closure body and compression spring the cover sealingly closes the installation chamber on a permanent basis and at the same time forms an end stop for the piston. A cover which screws onto the housing is suitable for fixing the cover. Alternatively the cover can be fixed on the housing by means of a snap-fit connection. The invention likewise includes a cover which is secured non-detachable for example by welded connection or adhesive.

The closure body which is formed as a piston is preferably provided with a seal which is inserted in a circumferential groove or an end side circumferential free area of the piston and on the outside sealingly adjoins by a sleeve face the inner wall of the installation chamber. A grooved ring seal is particularly suitable as a seal, wherein the radially spaced sealing lips are each pressed against the contact bearing faces with a build up of pressure in the operating system and thus improve the sealing action of the seal.

The invention further includes a damping device whose housing is formed from a push-in part and a socket part which are inserted with keyed engagement in each other. For fixing these component parts in position it is advisable to use for example a sleeve or casing which encloses the push-in part and socket part with restricted length on the outside and is fixed in position by radially inwardly aligned flanged edges on the end side.

As a further alternative the invention includes a direct positive-locking fastening between the socket part and push-in part. A snap-fit connection is particularly suitable which involves detent noses formed on one component part engaging in the installation position with keyed connection in corresponding designed recesses or indented areas of the associated other component part.

A further design of the invention proposes making the installation chamber for holding the resiliently arranged closure body circular wherein the installation chamber engages concentrically round the pressurised medium guide. Corresponding to the shaping of the installation chamber the circular ring-shaped ring piston is connected through a thin channel to the pressurised medium guide. A grooved ring seal whose sealing lips each dynamically adjoin the inner wall or central journal enclosing the installation chamber round the outside is used to seal a ring piston of this kind.

In order to achieve an elastic bearing support for the ring piston, the latter is supported on opposite sides by the seal against a compression spring. As an

alternative one or more plate springs or a coil spring can be inserted in the circular ring-shaped installation chamber.

A throttle valve can advantageously be integrated in the damping device according to the invention so that the device according to the invention can exert a double function. The shape and arrangement of the throttle valve allows an unimpeded or throttled flow of pressurised medium depending on the through-flow direction.

A perforated disc can be used for example as a throttle valve and is arranged displaceable in the region of the pressurised medium guide so that this allows an unimpeded flow of pressurised medium in a first end position. In a further end position, the throttle position, a flow of pressurised medium through the damping device is possible restricted up to the throttle bore of the throttle disc.

To improve the efficiency of the throttle valve this is preferably pretensioned towards the throttle position by means of a spring. A coil spring is particularly suitable for this purpose and is supported on the push-in or socket part and the throttle disc adjoins the associated further component part with force-locking engagement. The invention includes for optimising the number of component parts a throttle valve assembly whose function is guaranteed even without a separate spring.

The configuration of the invention further includes the combination of the damping device according to the invention with component parts of the hydraulic

operating system. By way of example it is possible to integrate the damping device in the pressure line which connects the master cylinder to the slave cylinder. The relatively small structural space required for the damping device also makes it possible to combine this with the master or slave cylinder. For slave cylinders which are designed as central release members it is possible to integrate the damping device in a pressure pipe of the slave cylinder which bridges a radial spacing between the slave cylinder and the clutch housing.

As a result of an improvement in the weight of the damping device according to the invention a pressure pipe for example which is provided with the damping device according to the invention requires no further fixing point.

The invention further includes combining the damping device according to the invention with a further element for damping vibrations in the hydraulic operating system. The damping device and the damping element thereby advantageously have different work principles. The component parts which are combined into one unit contain for example a spring-supported closure body associated with a membrane box or upstream pressure valve on the inlet or outlet side.

The problem outlined above is further solved according to the invention through a device for damping pressure vibrations wherein the membrane is formed as a cover and fixed with keyed engagement on the housing. This measure reduces the extent of component parts since compared to the known prior art the membrane does not require any further component for fixing. The membrane

which is formed as a cover is according to the invention fixed with keyed engagement on the housing and thereby sealingly closes a housing chamber. The reduced number of component parts enables cost-effective manufacture of the damping device. The invention further includes a housing made from plastics in order to provide a damping device of optimum weight.

In one embodiment of the invention the membrane is designed pot-shaped wherein its collar engages round a cylindrical shoulder of the housing. As a suitable method of fastening for example an end section of the collar can be flanged inwards to engage behind the housing shoulder. As an alternative a snap-fit connection can be provided between the pot-shaped membrane and the housing. To this end for example the cylindrical area of the housing can be provided with at least one, preferably several circumferentially spaced out retaining noses which with the membrane in an installation position engage with detent action in a recess or opening of the collar of the membrane.

According to a further development a sealing ring is provided for sealing the membrane, wherein the ring is preferably inserted in a circumferential groove or recess of the sleeve face of the cylindrical housing section which is enclosed by the collar of the membrane. As an alternative or in addition a sealing ring can be mounted in an end-side circumferential groove of the membrane contact surface of the housing or on the outside in an transitional zone between the end side and the sleeve face of the housing which is enclosed by the membrane.

In order to achieve improved damping of the damping device according to the invention the housing comprises two diametrically opposite membranes which are fixed directly on the housing according to the previous embodiments without any further fastening means.

According to a further advantageous embodiment of the invention the membrane comprises a cambered, i.e. curved housing base. A membrane with a housing base shaped in this way allows a deliberate influence to be made on the damping characteristic. Moreover a camber can also have an effect on the strength of the membrane. The invention includes both an inwardly and outwardly curved housing base.

One design of the housing provides two radially aligned connections to which are connected the pressure lines which provide a connection between the damping device and the master and slave cylinders. Alternatively the housing of a damping device can be provided with two axially coinciding pipeline connections which are arranged for example at right angles to the membrane on the housing.

The pipeline connections are preferably formed as a push-fit connection which allows a rapid automated assembly of the pressure lines on the damping device. To secure this pipeline connection a shaped spring is used which is mounted secured against loss in the pipeline connection of the housing and which in the installation position of the connector of the pressure line automatically locks for example in a ring groove of the connector.

To improve the action of the damping member the invention further includes a housing which is provided with a labyrinth-type pressurised medium guide in the damping chamber. The labyrinth increases the dwell time of the pressurised medium vibration in the damping member which can thereby bias the membrane for longer. This measure thus improves the damping characteristic of the damping member.

A further measure according to the invention for influencing the damping characteristic proposes a defined stiffness or softness of the housing. The membrane in conjunction with the housing thus allows a deliberate increase in volume, dependent on the pressure of the hydraulic medium.

According to the invention in order to reduce the inherent weight of the damping device the housing is made from plastics. This makes it possible in an advantageous way to mount the damping device inside the pressure line without any further support. A reinforced thermoplastics is preferably used as the plastics. A thermosetting plastics can likewise be used as an alternative.

According to a further invention it is proposed to insert the membrane in a housing recess which has a security ring mounted in front on the outside. In order to fix the membrane and security ring an edge on the housing side is flanged inwards at least in sections.

A seal is used to seal a membrane mounted in this way wherein the seal is inserted in a circumferential groove on an end side of the housing in the area of the

membrane support surface. In the installed state the seal adjoins the membrane with pretension.

One design of the invention proposes that a damping device can be provided with two membranes mounted opposite one another and each inserted in a housing recess.

The invention further proposes mounting or installing the damping member in any way in a component part of the hydraulic operating system. The damping member can consequently be mounted on the master or on the slave cylinder dependent on the installation conditions. Furthermore an arrangement is also suitable inside the pressure line which connects the master cylinder to the slave cylinder.

According to further inventive solutions the damping device comprises a housing having a recess surrounded on the outside by an edge to hold the membrane and a security element mounted in front of same. The component parts which are each in the form of a disc are fitted into the recess of the housing and in order to fix the membrane and disc in position the edge of the housing is flanged inwards at least in sections or round the entire circumference. The security element which is formed as a disc is thereby cambered, i.e. curved outwards in the installation position to allow the membrane to vibrate freely when pressure pulsations arise in the hydraulic operating system. At the same time the cambered disc allows an effective lift restriction for the membrane. Furthermore this damping device according to the invention provides a space-saving solution, connected with a weight improvement

which further reduces the assembly expense and thus offers cost advantages overall.

An advantageous embodiment of the damping device comprises a housing made from plastics and combined with a membrane of spring steel and with a security element of plastics which surrounds the membrane. The choice of materials likewise meets the demands relating to a weight improvement. As an alternative to a security element made of plastics it is possible where necessary to use a security element which is made without stock-removal from steel or steel plate by a deep drawing process.

A further inventive idea relates to a disc-shaped housing, preferably made of plastics, on which the membrane is supported at an end side and which is provided with pipe connections on the side remote from the membrane. The associated security element of the damping device is designed pot-shaped and its edge is formed so that it exceeds the thickness of the housing part. In the installed position the edge of the security element surrounds the housing completely on the outside and ensures the housing is fitted secure in the security element through an inwardly aligned angled edge at the end. This construction likewise produces a damping device involving optimum structural space and offering for example in conjunction with a disc made from plastics, weight advantages. The formation of the individual component parts of this damping device is furthermore cost-effective and requires only a slight assembly expense in order to produce a most cost-effective damping device.

One further development of the damping device proposes mounting the pipeline connections within the circular contour of the housing. The pipeline connections which are preferably opposite one another parallel to the membrane reduce the structural space required by the damping device. A flow pressing process or injection moulding process is particularly suitable for a housing of this kind made from aluminium and also represents a cost advantage when making a high number of parts.

One design of the invention relates to a security element made without stock removal through a deep-drawing process and having a central passage which in the installed state forms a lift restriction for the membrane. In the neutral position, i.e. when the membrane is not loaded with pressure a gap width is provided between the passage and the membrane.

To fix the pot-shaped security element on the housing it is proposed that the edge of the security element surrounds an outer region of the housing. For positioning, the free end of the edge is angled radially inwards and engages behind a shoulder of the housing. As an alternative it is proposed to provide a snap-fit connection between the edge of the security element and the sleeve face of the housing. Snap-fitting noses protruding radially from the sleeve face of the housing are particularly suitable and in the installed state of the security element snap-fit in corresponding openings in the edge.

For a security element and a housing which are made from matching materials it is possible to weld the edge of the security element and the housing together to produce a permanent connection. As an alternative to

this material-bonding connection it is also possible to use adhesive.

For an effective seal between the membrane and the housing it is possible to use a sealing ring which is preferably inserted in a circumferential groove on the housing on an end contact bearing face for the membrane and is supported in the installed position on the membrane with pretension. For an improved seal of the damping device a separate sealing ring can be allocated for both the membrane and the security element. Apart from the sealing of the membrane previously described a further sealing ring is inserted in a ring groove of the cylindrical sleeve face of the housing which is covered in the installed state by the edge of the security element.

For a further advantageous development of the invention a pot-shaped security element is provided as the membrane holder and has a conical circumferential outer contour. For this the housing is provided with a corresponding socket in which the security element is inserted. To position and fix the security element this is preferably welded or stuck in the region of the conical circumferential outer contour. The arrangement of this security element means that in the installed position this is mounted at a defined axial spacing from the membrane to thus provide a guaranteed lift restriction for the membrane.

The invention further includes a housing which is provided with two parallel mounted membranes each allocated a security element which at the same time produces a lift restriction.

The damping device according to the invention can be provided with pressure line connections aligned in different directions. These can emerge radially from the housing for example. Alternatively the housing can be provided with pressure line connections arranged at right angles to the membrane and spaced from each other to emerge from the housing pointing in one direction.

In order to improve the action of the damping device according to the invention it is proposed to provide the damping chamber of the housing which is closed at the side by the membrane, with a labyrinth-type guide for the pressurised fluid. This housing design prolongs the dwell time of the pressurised medium vibrations or pressure impulses in the damping device and thus biases the membrane for longer which affects the damping characteristic, i.e. improves the damping action.

In an advantageous manner the damping device according to the invention allows the damping device to be associated or installed in any way in a component part of the hydraulic operating system. By way of example this can be connected both to the master cylinder and to the slave cylinder depending on the installation conditions. Furthermore the damping device can be inserted inside the pressure line or can be connected to same which connects the master cylinder to the slave cylinder.

Hydraulic systems are used as already mentioned inter alia for operating a shift and separate clutch of vehicles. The structure of this operating system comprises a master cylinder which is preferably in active connection with a pedal which is to be manually

operated. A pressure line connects the master cylinder to the slave cylinder which acts through a release bearing directly on the shift and separate clutch which is connected to the internal combustion engine. AS a result of the method of operation and the type of construction of the internal combustion engine which comprises several oscillating drive trains, the crankshaft of the internal combustion engine connected to the shift and separate clutch is subjected to a constant change between an acceleration and a deceleration phase. Conditioned by the ignition pressure or the gas forces in the combustion chamber of the internal combustion engine which are transferred from the piston via the drive train to the crankshaft, the result is a high-frequency expansion of the lever arms of the crankshaft which trigger axial vibrations. Through the direct coupling of the shift and separate clutch to the crankshaft the axial vibrations are transferred into the hydraulic operating system leading to pressure pulsations which are transferred to the manually operated pedal on the master cylinder and result in unacceptable tingling which causes a severe loss of comfort. As a result of the slight vibration-reducing masses in a hydraulic operating system the transfer of vibrations is more intensive than with a mechanical system.

In order to improve the operating comfort of the hydraulic operating system this is provided with a damping device in the housing of which is inserted a valve support having two valve elements arranged off-set and associated with different flow directions. Each spring-biased valve element forms a sealing seat with the valve support.

In order to avoid these pressure pulsations and pressure vibrations it is known to use pressure accumulators. Furthermore it was attempted by extending the hydraulic leads or by installing hydraulic throttles or diaphragms to increase the flow resistance so that this opposes the vibrations with sufficient resistance. The axial movement of the crankshaft initiates a displacement in the volume, which in turn in the hydraulic operating system triggers a substantially slower flow speed in the pressure lines than occurs when coupling and disengaging the operating system. Therefore the degree of efficiency of the operating system is unfavourably influenced by any measure which increases the flow resistance.

From DE 44 28 074 A1 a valve assembly is known where two valve elements formed as balls are supported on the valve support of same. The valve seats associated with the valve elements are mounted on end sides of the valve support remote from each other. A recess is provided in each housing half between which the valve support is inserted, to hold a compression spring which is supported between the housing and the valve element. The valve element which is formed as a ball lies in the closed position with linear contact against the conical formed valve seat. A flow of pressurised medium can thereby take place as soon as the pressure arising at a valve element and exerted by the pressurised fluid on the valve element is greater than the counter pressure exerted by the compression spring. In the opened position pressurised fluid circulates round the valve element producing a detrimental turbulent flow as a result of the configuration of the valve seat and the valve element on the output side thereof. This can

lead to an unstable position of the valve element, connected with the generation of noise which is caused by the valve element fluttering open.

Starting from the faults of the known solution, the object of the invention is to provide a damping device so that its valve element occupies a stable position in the opened state and stops any generation of noise.

The problem outlined above is solved according to the invention through a damping device where only one overflow channel is assigned to each cylindrical-shaped valve element. The overflow channel formed in the valve support and running parallel to the longitudinal axis of the valve element produces in the opened position a stable contact between the valve element and the guide of the valve support. The overflow on one side of the valve element in place of the circumferentially spaced out arrangement of several overflow channels which has been standard up until now ensures that the flow pressure of the pressurised fluid biases the valve element so that this is supported calmly on the valve support on the side opposite the overflow channel. Any development of noise as a result of indifferent states of the valve element is thereby effectively avoided. The arrangement of the overflow channel according to the invention thus stops any fluttering open, i.e. a rapid periodic lifting and closing of the valve element from the valve seat. Any fluttering open of the valve element is transferred in the hydraulic operating system up to the pedal and causes a disturbing pedal sensation.

The invention further includes designing the overflow channel which is associated with the valve element on

one side so that its cross-sectional profile increases starting from the valve seat. The increase in the overflow surface area is thereby dependent on the stroke of the valve element, i.e. the lifting off from the valve seat. This structural design measure has a positive effect on the function of the damping device and represents a further security against the disadvantageous fluttering of the valve element.

An advantageous development of the invention provides the formation of a valve seat in the valve support which has an inflow channel of reduced diameter compared with that of the valve element. The valve support thereby forms an axially protruding shoulder of the inflow channel on which the valve element is supported inwardly off-set at the end radially relative to its outer contour. A valve seat of this kind ensures a defined bearing of the valve element through which the desired damping characteristic or function of the damping device can be achieved.

The axially protruding shoulder in the valve support creates an undercut section in the form of a ring channel arranged radially off-set relative to the shoulder or valve seat. The overflow channel starts from the ring channel or undercut section and runs on one side to the valve element. This valve seat according to the invention on the one hand meets the requirements for an effective seal when the valve element is closed and on the other hand prevents the valve element from fluttering open independently of its degree of opening. Immediately after the valve element is lifted from the valve seat, as a result of the undercut section formed as the ring channel, the entire end face of the valve element is biased by the

pressurised fluid which rules out any crooked position of the valve element. The flow pressure which acts on one side and which is set after opening ensures a stable bearing contact of the valve element against the valve support throughout the entire stroke of the valve element.

As a measure which allows a practically constant flow resistance, the overflow channel increases practically continuously throughout the stroke of the valve element starting from the undercut section or ring channel in the region of the valve seat. It is thereby ensured that the flow of pressurised medium which increases with the opening of the valve element flows round the valve element practically free of resistance or with a constant flow resistance.

The overflow channel can further be designed according to the invention so that the increase in cross-section starting from the ring channel is first made to increase sharply in a first section followed by a section with a clearly reduced rise in relation to the stroke of the valve element.

To optimise flow the inflow cross-section is formed in the valve support on the side remote from the valve seat as a Venturi nozzle. Further measures having a favourable effect on the flow propose making the overflow channel rounded, for example in the form of a circular arc, as well as providing the end side of the valve element where the pressurised medium flows, with a frusto-conical shoulder.

An advantageous linear contact of the valve element on the axially protruding shoulder of the seal support is

ensured according to the invention by forming the end face inclined or conical. The linear type contact of the valve element creates a narrowly restricted sealing gap which with the slightest lift of the valve element allows a flow of pressurised medium which has an advantageous effect on the position of the valve element. This structural measure meets the demand for a stable position of the valve element in the opened position.

The overflow cross-section which runs on one side to the valve element is advantageously made larger than the inflow cross-section associated with the valve element. It thereby presents itself to make the overflow channel at least 5 % larger than the corresponding cross-section of the inflow channel.

A further advantageous development of the invention proposes a symmetrically shaped valve element whose end sides each have frusto-conical projections. This structural shape requires no directional assembly thereby eliminating any faulty fitting. The frusto-conical projection opposite the valve seat can be used to centre the compression spring which is inserted between the housing of the damping device and the valve element and which creates a force component on the valve element acting in the direction of the valve seat.

In order to centre the compression spring in the housing the latter is provided with a recess which forms a central shoulder on which on one side the compression spring is centred and which on the other side forms an end stop for the valve element.

A secure guide of the valve element in the valve support is ensured by observing an installation play of > 0.01 mm between the mounting in the seal support and the sleeve face of the valve element.

Metal materials are the most suitable materials for the sealing element of the damping device according to the invention. Plastics is preferably provided for the sealing support and the housing of the damping device.

The invention will now be explained in further detail with reference to several embodiments shown in the thirty-two figures in which:

Figure 1 shows a damping device whose closure body is mounted at right angles to the flow direction;

Figure 2 shows the design of a circular ring shaped closure body which is arranged concentric with the pressurised medium guide of the damping device;

Figure 3 shows a circular ring shaped closure body which adjoins a coil spring;

Figure 4 shows a damping device with two different work principles;

Figure 5 shows an alternative to the damping device shown in Figure 3 and having an integrated throttle valve;

Figure 6 shows the damping device according to Figure 5 wherein the throttle valve is formed in the closed i.e. throttle position;

Figure 7 shows a damping device whose housing is formed by a socket part or a push-in part which are connected together with keyed engagement;

Figure 8 shows a damping device according to the invention integrated in the master cylinder;

Figure 9 shows a slave cylinder with a damping device inserted in the pressure pipe thereof;

Figure 10 is a sectional view showing the design of the membrane which is fixed on the housing by means of a flanged end area;

Figure 11 shows a membrane which is mounted by means of a snap-fit connection on the housing whose damping chamber has a labyrinth;

Figure 11a is a sectional view along the line 2a-2a according to Figure 11;

Figure 12 shows a membrane with a cambered housing base;

Figure 13 shows a housing of a damping member having two membranes which both have a cambered housing base;

Figure 14 shows a damping member having pipeline connections aligned axially with the membrane;

Figure 15 shows a damping member having pipeline connections aligned axially with the membrane wherein the membrane is fixed in position according to Figure 6;

Figure 16 is a sketch showing the construction principle of a hydraulic operating system;

Figure 17 shows a security element in connection with a membrane which are inserted together in an end-side recess of the housing wherein for positioning and fixing, a circumferential edge of the housing is flanged over inwards;

Figure 18 shows an alternative form of damping device wherein the pot-shaped security element is fixed on a cylindrical section of the housing;

Figure 19 shows a damping device wherein the disc-like housing and the membrane are integrated in a pot-shaped security element;

Figure 20 shows a damping device whose membrane is enclosed by a security element which has a lift restriction;

Figure 21 shows a security element made without stock removal from sheet metal and associated with a disc-like membrane;

Figure 22 shows a damping device whose housing comprises two parallel spaced membranes;

Figure 23 shows a damping device with a labyrinth mounted in the damping chamber of the housing;

Figure 24 shows a sectional view of the damping device along the section line 8-8 of Figure 23;

Figure 25 shows a sketch of the design principle of a hydraulic operating system;

Figure 26 shows a longitudinal sectional view through a damping device according to the invention;

Figure 27 shows the valve element according to Figure 26 on an enlarged scale in the closed position;

Figure 28 shows the valve element as in Figure 27 but in the opened position;

Figure 29 shows a further illustration corresponding to Figure 27 of an alternative design of valve element;

Figure 30 is a view, in the direction of the arrows in Figure 29, showing the shaping of the overflow channel as well as the mounting for the valve element in the valve support;

Figure 31 shows the through-flow characteristic line through the damping device according to the invention; and

Figure 32 shows the through-flow characteristic line of a conventional shaped valve element.

A damping device is shown in longitudinal section in Figure 1. The damping device 1a which is formed as an individual part is provided for installation in a pressure line (not shown) which connects a master cylinder to a slave cylinder of the hydraulic operating system for shift and separate clutch. The structure comprises a housing 2 having two pipeline connections formed as push-in connections 3, 4. The housing 2 is provided in one piece at right angles to the longitudinal axis 5 with a neck 6 which forms a cylindrical installation chamber 7 in which a closure body, formed as a piston 8, is inserted. The installation chamber 7 is closed by a pot-shaped cover 9 whose edge 10 is flanged inwards at the end radially in sections or circumferentially to engage in a ring groove 11 of the neck 6. The piston 8 is supported elastically on the cover 9 through plate springs 12. The plate springs 12 which are each punched and combined into a parcel are centred on a cylindrical neck 13 of the piston 8. According to Figure 1 the plate spring parcel comprises two plate springs 12 layered in alternate directions and two plate springs layered in the same direction. This different assembly of the plate springs 12 makes it possible to influence the stiffness and thus the damping characteristic relative to the pressure vibrations which appear in the hydraulic operating system.

Facing towards the longitudinal axis 5 or to the pressurised medium supply 21 in the housing 2 the piston 8 is provided with a seal 14 which is formed as a grooved ring seal. The seal 14 which is inserted in

a ring groove 18 lies with a static sealing lip 16 against the base of the ring groove 18. The additional dynamic sealing lip 17 is on the other hand guided with sealing action on an internal wall 19 of the neck 6. Applying pressure to the piston 8 leads to the piston 8 being displaced in the direction of the arrow. The piston 8 is restricted in travel against the cover 9 which for this purpose has a step 20 adapted to the neck 13 of the piston 8. The maximum travel "h" is set through the distance provided in Figure 1 between an end face of the neck 13 and the cover 9 in the region of the step 20.

The damping device 1b illustrated in Figure 2 comprises two housing parts, a socket part 22a and a push-in part 23a, which engage in each other with keyed connection and are held together by means of a sleeve 24a. A ring piston 25 which is guided concentric with the pressurised medium guide 21 or with the longitudinal axis 26 on a shoulder 27a of the socket part 22a serves as the resiliently supported closure body. Plate springs 28 arranged alternately and inserted between the ring piston 25 and a shoulder 29a of the socket part 22 are likewise guided on the shoulder 27a. The circular ring shaped installation chamber 30a, for holding the ring piston 25, restricted on the inside by the shoulder 27a is enclosed on the outside by the wall 31a of the push-in part 23a. In front of the disc-like ring piston 25 on the pressure chamber side is a seal 32 whose dynamic sealing lips 33, 34 during axial displacement of the ring piston 25 are supported with sealing action against the shoulder 27a or against an inner wall 35 of the push-in part 23a. In order to bias the installation chamber 30a with pressure a thin

channel 36 is provided on an end side of the push-in part 23a through which pressurised medium can flow from the pressurised medium guide 21 into the installation chamber 30.

The ring piston 37 of the damping device 1c illustrated in Figure 3 has an L-shaped cross-sectional profile and is supported in the neutral position by an edge 38 on the end side against the wall 31b. To seal the ring piston 37 a quad ring 39 is used which in the installed state sealingly adjoins the wall 31b or sleeve face of the shoulder 27b under pretension. The installation chamber 30b which is mounted concentric with the pressurised medium guide 40 is connected to the pressurised medium guide 40 through a thin channel 41 in conjunction with a longitudinal channel 42 formed as a recess in the push-in part 23b. The elastic support of the ring piston 37 is produced by means of a coil spring 43 which is supported by one spring end against the shoulder 29b and by the further spring end against the ring piston 37. The sleeve 24b with which the socket part 22b is connected to the push-in part 23b at the same time encloses the coil spring 43. The maximum travel of the ring piston 37 which is characterised by the measurement "h" is set in the neutral position between the ring piston 37 and a stop 53 on the socket part 22b. As an alternative to the quad ring 39 it is possible to provide a friction-reducing rolling membrane for sealing the installation chamber 30b.

Figure 4 shows the damping device 1d which has a combination of two independent spring-supported closure bodies with different active principles. Two additional closure bodies formed as valve bodies 44a,

44b are associated in the axial direction with a ring piston which corresponds in structure and function identically to the ring piston illustrated in Figure 2. The valve bodies 44a, 44b arranged radially off-set in the disc like valve element 46 are each designed as one-way valves, that is, associated with one through direction. The relatively small fully cylindrical shaped valve bodies 44a, 44b are guided axially displaceable in the valve element 46 and each form with the valve element 46 a valve seat 47a, 47b. On the opposite side from the valve seat 47a, 47b a coil spring 45a, 45b adjoins each of the two valve bodies 44a, 44b, with the further spring end being centred on a shoulder 48a, 48b of the socket part 22c or push-in part 23c. After lifting off from the valve seat 47a, 47b the valve bodies 44a, 44b which open in the direction of the arrow allow pressurised medium to flow through overflow channels 49a, 49b which are formed in the valve element 46.

The damping device 1e according to Figures 5 and 6 corresponds substantially to the damping device 1c illustrated in Figure 3. The following description is thus solely based on the throttle valve 54 integrated additionally into the damping device 1e. A disc 55 which is supported at the end on the socket part 22 and on the outside is guided in a socket 64 of the push-in part 23b serves as the throttle valve 54. The position of the disc 55 illustrated in Figure 5 is comparable with the free passage of the throttle valve 54 wherein the pressurised fluid passes both through the central throttle bore 62 and through the recess 65 in the region of the socket 64 of the push-in part 23b and through the overflow channel 63 of the socket part 22b into the pressurised medium guide 21.

The throttle position of the throttle valve 54 is shown in Figure 6. The disc 55 thereby lies on the outside flat against a radially inwardly directed shoulder 61 of the push-in part 23b and forms a valve seat 60. In this position of the disc 55 the pressurised fluid guided through the pressurised medium guide 21 in the direction of the arrow can pass the throttle valve 54 solely through the central throttle bore 62. A spring-tensioned position of the disc 55 corresponding to the throttle position is produced by means of a compression spring 59 which is inserted between the socket part 22b and the disc 55.

Figure 7 shows the damping device 1f whose structure differs from the damping device 1c according to Figure 3 through a different fixing between the socket part 22d and push-in part 23d. As an alternative to the sleeve fastening, the outer wall 66 of the push-in part 23d is provided with at least one recess 57 in which a detent nose 58 of the socket part 22d fits with keyed engagement in the installation position. In order to achieve an elastic fault-free radial deflection of the outer wall 66 when sliding the socket part 22d into the push-in part 23d, the outer wall 66 is provided with at least one longitudinal slit 67. The outer wall 66 is preferably provided with several recesses 57 spread out circumferentially and formed in the outer wall 66 in alternation with the longitudinal slits 67.

Figure 8 shows a master cylinder 50 which is combined with a damping device 1a shown in Figure 1. The individual component parts of the damping device 1a are provided with the reference numerals corresponding to Figure 1 so that reference can be made to the

description of the design according to Figure 1. Figure 8 shows the possibility of combining the damping device 1a according to the invention with the master cylinder without substantially increasing the structural space required.

Figure 9 shows a slave cylinder 51 whose pressure pipe 52 is provided with the damping device 1a. This arrangement also does not significantly increase the structural space required and thus allows the component part of the operating system to be combined with the damping device according to the invention in optimum manner regarding both the component parts and the structural space.

Figure 10 shows a damping member 101a according to the invention and comprising a housing 102a made from plastics. The housing 102a forms a cylindrical damping chamber 103 open on one side and provided with two radially outwardly directed pipeline connections 104, 105 for attaching pipelines 106, 107 which provide a link to a master cylinder 108 and a slave cylinder 109 according to Figure 16. The damping chamber 103 is closed by a membrane 110a, formed as a pot-shaped cover, and made preferably from a metal material. The membrane 110a engages by a circumferential collar 111 round a cylindrical end area of the housing 102. To produce a positive locking fixed position of the membrane 110a on the housing 102a, a free end section 113 of the collar 111 is angled radially inwards in sections or round the circumference and thereby engages behind a shoulder 112 of the housing 102a. A circumferential groove 114 formed in the sleeve face of the shoulder 12 serves to hold a sealing ring 115a which in the installed state adjoins the inside of the

collar 111 under pretension and thus ensures a secure seal between the membrane 110a and housing 102a.

Figure 11 shows the damping member 101b which differs from the damping member 101a according to Figure 10 through an alternative type of fixing for the membrane 110b on the housing 102b. For this purpose the collar 111 of the membrane 110b is provided with circumferentially spread out recesses 116 or with openings in which in the installed state of the membrane 110b retaining noses 117 connected integral with the housing 102b automatically engage with keyed connection to produce a permanent fixing of the membrane 110b.

The sectional view of Figure 11a along the line 2a- 2a of Figure 11 shows the structural shape of the damping chamber 103. This is provided with a labyrinth 128 which the pressurised fluid has to follow when flowing through the damping member 101b. The labyrinth 128 prolongs the dwell time of the pressurised fluid which has a positive effect on the damping of the pressure vibrations.

The damping member 101c according to Figure 12 is provided with a membrane 110c having a cambered, i.e. curved housing base 118. The curvature of the housing base 118 is thereby aligned pointing in the direction of the damping chamber 103. A further difference between the damping member 101c and those damping members 101a, 101b according to Figures 10 and 11 is in the sealing of the membrane 110c. To this end the sealing ring 115b is inserted in a transition zone between the cylindrical surface area and the end contact face of the membrane 110c in a corresponding

recess 119 of the housing 102c. For fixing, the collar 111 of the membrane 110c is shrink-fitted onto the shoulder 112 of the housing 102c. As an alternative it is possible to provide a material-bonding connection between the membrane 110c and the housing 102c, e.g. through adhesive or welding.

Figure 13 shows the damping member 101d which comprises a tubular shaped housing 102d whose openings are each closed by a membrane 110d. Both membranes 110d are designed to match each other and are provided with a cambered, i.e. outwardly curved housing base 120. The fixing of the membranes 110d agrees with that of the membrane 110b shown in Figure 11.

The damping member 101e according to Figure 14 has as opposed to all the damping members 101a to 101d previously described a housing 102e whose pipeline connections 104, 105 are aligned pointing in the same direction at right angles to the membrane 110e. In order to fix the membrane 110e on the housing 102e, its collar 111 extends over a wide cylindrical end section of the housing 102e and is connected non-detachable to this through material contact, preferably through welding or adhesive. As an alternative it is also possible to provide a snap-fit connection. The seal for the membrane 110e comprises a sealing ring 115b which is inserted at the free end of the sleeve face of the housing 102e into a recess 119 and is thus comparable with the sealing of the membrane 110c according to Figure 12.

Figure 15 shows in semi-section the damping member 101f wherein the pipeline connections 104, 105 are aligned at right angles to the membrane 110f. The membrane

110f is thereby inserted in agreement with the membrane 110f shown in Figure 15 into a recess at one end of the housing 102g and is supported against a circular ring-shaped contact bearing 124 of the housing 102f. A security ring 121 is mounted in front of each membrane 110f. To fix the security ring 121 and thus the membrane 110f in position the edge 125 of the housing 102f enclosing the recess 123 is flanged over inwards to produce a positive-locking fastening. The sealing of the membrane 110f from the housing 102f is through a sealing ring 115c which is inserted in a ring groove 122 at an end of the contact bearing 124 and is thus supported sealingly against the membrane 110f in the installed state.

The sketch showing the design principle according to Figure 16 shows all the essential component parts of a hydraulic operating system 129 for a shift and separate clutch for vehicles. The master cylinder 108 is thereby connected to a clutch pedal 26 which is to be operated manually or to an actuator (not shown here) which can be operated electrically and executes an axial movement to operate the piston rod of the master cylinder 108. A transfer of the pressurised medium pressure from the master cylinder 108 to the slave cylinder 109 connected to a shift and separate clutch 127 is carried out through the pressure line 106, 107. A damping member 101a is used to dampen the pressure vibrations which are transferred from an internal combustion engine through the shift and separate clutch 127 to the hydraulic operating system 129. According to the invention the damping member 101a can be inserted in the master cylinder 108, in the slave cylinder 109 or between the pressure lines 106 and 107. A fixed association is not provided but rather the

damping member 101a can be arranged in any one of the said three positions of the hydraulic operating system 129. Thus the arrangement of the damping member 101a shown in Figure 16 is to be considered as only one example of installation which can be advantageous for all those in the application documents. It is obvious that the arrangement of the remaining component parts such as for example placing the slave cylinder around the gear input shaft or at another point with corresponding transfer means such as rod linkages can be examples of the inventive idea. Furthermore the damping device 101a can be integrated in one of the remaining component parts of the hydraulic circuit, such as for example in the master cylinder 108 or the slave cylinder 109.

Figure 17 shows in semi-section a damping device 201a wherein a membrane 205a and a security element 206a are inserted in a recess 221 on the side of a housing. In order to position and fix these inserted component parts, an edge 222 of the housing 202a is flanged or angled inwards at the end at least in certain sections and thus engages over the outer contour of the security element 206a and membrane 205a. The seal for a pressure chamber 203 on the membrane side is provided by a sealing ring 210 which is inserted in the outer area of the contact bearing face of the membrane 205a in a circumferential groove 211 of the housing 202a and sealingly adjoins the membrane 205a under pretension. The security element 206a is cambered, i.e. is curved outwards and thus provides a restriction for the membrane 205a. The pipeline connections 212, 213 are mounted in the housing 202a parallel to the membrane 205a. The compact construction of the damping device

201a is enhanced by mounting the pipeline connections 212, 213 within the outer contour of the housing 202a.

The damping device 201b illustrated in Figure 18 comprises the component parts security element 206b and housing 202b which are made matching each other from plastics. The pot-shaped security element 206b engages by the edge 207b round an end region of the cylindrical shaped housing 202b. In the installed position the security element 206b is axially spaced from the membrane 205b which is made of steel wherein an axial distance "s" defines a maximum protrusion of the membrane 205b and thus provides an effective lift restriction for the membrane 205b. To fix the security element 206b in position on the housing 202b which are made matching each other from plastics, it is possible to use in particular a material-bonding connection, for example welding or adhesive in the region of the contact bearing surfaces of the edge 207b against the sleeve face of the housing 202b.

The damping device 201c according to Figure 19 has a compact construction which optimises the structural space available. To this end the housing 202c which is preferably made from plastics is formed as a disc which is integrated together with the membrane 205c in the pot-shaped security element 206c. The security element 206c thereby completely encloses the housing 202c and the membrane 205c at least radially. The edge 207c of the security element 206c thereby extends over the width of the membrane 205c and housing 202c. At its free end, the edge 207c is flanged inwards in sections or round the circumference and engages with keyed connection behind the outer contour of the housing

202c. In order to form the damping chamber 203 the housing 202c is provided on the membrane side with a circular ring-shaped recess which is covered by the membrane 205c. In order to seal the damping chamber 203 the sealing ring 210 is used which is inserted at the end side into a circumferential groove 211 of the housing 202c and is supported in the installed state on the membrane 205c. On the side remote from the housing 202c the membrane 205c is supported on the outside on a spacer ring 223 which is formed as a sealing ring which is inserted as a loose part in the security element 206c and ensures an axial spacing between the base 225 of the security element 206c and the membrane 205c. A swage 224 formed centrally in the base 225 of the security element 206c to produce a curvature on the membrane side defines a gap width and thereby forms a lift restriction for the membrane 205c.

Figure 20 shows the damping device 201d in semi-section. The structure comprises a housing 202d which forms a cylindrical damping chamber 203 which is closed at the end by a base 204. On the sides remote from the base 204 the housing 202d is closed at the end by a membrane 205d. The security element 206d is mounted in front of the disc-shaped membrane 205d which is preferably made from a metal material. The security element 206d, advantageously produced by deep-drawing without stock removal from a steel plate, engages by its circumferential edge 207d round a cylindrical end section of the housing 202d. For position fixing, a free end of the edge 207d is flanged inwards or angled inwards and engages behind a radial shoulder 208 of the housing 202d. The security element 206d is mounted in the installed position axially spaced from the membrane 205d by means of a radially stepped edge 207d. A

passage 209 formed centrally in the security element 206d and aligned towards the membrane 205d is passed in the installed position up to the membrane 205d whilst maintaining the gap width "s". An effective seal of the pressure chamber 203 is formed by the sealing ring 210 which is inserted in a circumferential groove 211 at the end of the housing 202d and which in the installed position is supported on the membrane 205d under pretension. The housing 202d is provided with two radially extending pipeline connections 212, 213 which are formed as push-fit connections to connect the pressure lines through which a connection can be made to a master cylinder 227 and a slave cylinder 230 of the hydraulic operating system 226, according to Figure 25. The pipeline connections 212, 213 can be mounted anywhere on the housing 202d which to save weight is preferably made by an injection moulding process from plastics, thermoplastics or thermosetting plastics.

Figure 21 shows the damping device 201e whose security element 206e which is shaped from sheet metal has in the region of the edge 207e a seal to seal the membrane 205e. To this end a ring groove 215 is formed in the sleeve face of the housing 202e to hold the sealing ring 214 which on the inside adjoins the edge 207g of the security element 206e under pretension. Sealing the membrane 205e from the housing 202e corresponds to the variation depicted in Figure 20. The security element 206e is mounted with a large surface area at an unchanged axial distance from the membrane 205e. To fix the security element 206e the latter can be fastened by way of example by adhesive or welding between the edge 207e and the housing 202g. A shrink-

fit connection between these component parts is offered as an alternative.

The damping device 201f according to Figure 22 has two membranes 205f arranged parallel to each other on the housing 202f. To this end the housing 202f is provided at each end with a recess 216 which forms a circular ring-shaped contact bearing face 217 on which the membrane 205f is supported. The security element 206f is mounted in front of the membrane 205f and is supported with an outer collar 218 on the membrane 205f. The collar 218 which protrudes axially relative to the base 219 of the security element 206f creates a gap width which is set between the base 219 and the membrane 206f and defines the vibration amplitude of the membrane 206f to thus form a lift restriction. The recess 216 in the housing 202f runs conically from the contact bearing surface 217, i.e. expands radially. The outer contour of the security element 206f is designed according to this configuration and fits in accordingly with keyed engagement. In order to produce an effective sealed connection between the component parts security element 206f and housing 202f which are made to match each other from plastics, these component parts are connected together with material bonding, more particularly through ultra sound welding, in the contact surface formed by the recess. As an alternative it is possible to use adhesive for example. With this design it is possible to eliminate a separate seal between these component parts using a sealing ring.

Figures 23 and 24 show the damping device 201g with the membrane 205c and the security element 206c which in shape and arrangement agree with the corresponding

component parts illustrated in Figure 19. Consequently these component parts are also provided with the corresponding index letters. The damping chamber 203 of the damping device 201g forms a labyrinth 220 whose structure is shown in Figure 24. As a result of the bearing contact at the end between the membrane 205c and the individual segments of the labyrinth 220 the pressurised fluid flows through the damping device 201g in the labyrinth 220. The dwell time of the pressure vibration or pressure pulsation in the damping device 201g is advantageously prolonged through the labyrinth 220 which affects the damping characteristic and thus has a positive action on the damping to improve the operating comfort of the hydraulic operating system for shift and separate clutches.

The illustration of Figure 25 shows all the essential component parts of a hydraulic operating system 226 for a shift and separate clutch 229 for vehicles. According to this the master cylinder 227 is connected to an actuator 228 or to a clutch pedal 228 which is to be manually operated. A transfer of pressurised medium from the master cylinder 227 to the slave cylinder 230 which is provided with a shift and separate clutch 229 is provided through the pressure line 231, 232. A damping device 201a is used in order to dampen the pressure vibrations which are transferred from an internal combustion engine through the shift and separate clutch 229 to the hydraulic operating system 226. There is no fixed association but rather the damping device 201a can be mounted in any one of the said three positions of the hydraulic operating system 226. Thus the arrangement of the damping device 201a shown in Figure 25 is only to be considered as one example of installation.

Figure 26 shows a damping device 301 which comprises two rotationally symmetrically shaped housings 302, 303 which fit together with keyed engagement. The two housings 302,303 are each provided with matching push-fit connections 304, 305 for attaching for example pressure pipes through which the damping device 301 is connected to a master cylinder and a slave cylinder of the hydraulic operating system for a shift and separate clutch. The housing 302 holds on the end remote from the push-fit connection 304 a cylindrically shaped valve support 306 which is supported on a shoulder 307 of the housing 302. An end-side shoulder 308 of the housing 303 is inserted in the housing 302 and in the installed position is supported on the seal support 306. The valve support 306 as well as the shoulder 308 of the housing 303 are each inserted sealed in the end-side mounting of the housing 303. Sealing rings 312a, 312b are used here which are each inserted in a ring groove of the valve support 306 or shoulder 308 of the housing 303 and which sealingly adjoin a bore wall 311 of the housing 302. All the component parts of the damping device 301 are held together secured against loss by means of a sleeve 309 which encloses the assembled sections of the housing 302, 303. The sleeve 309 is provided at the end with radially inwardly aligned flanges 310a, 310b for positioning.

The valve support 306 serves to hold and guide two radially off-set valve elements 313, 314. Shoulders 315, 316 each form in a continuation of an inflow channel 328 in the valve support 306 a valve seat 317, 318 for the valve element 313, 314. The arrangement of the valve elements 313, 314 is such that these are to

be opened in different flow directions, marked by arrows. Each valve element 313, 314 is assigned a compression spring 319, 320 which with one spring end adjoins the housing 302, 303 and with the other spring end is supported on the valve element 313, 314 and triggers a force component in the direction of the valve seat 317, 318. When the valve element 313, 314 is opened when the pressure of the pressurised fluid exceeds the force of the compression spring 319, 320 and the valve element 313, 314 is moved from the valve seat 317, 318, the pressurised fluid can flow round the valve element 313, 314 through the overflow channel 321, 322.

Figures 27 and 28 show the arrangement of the valve element 313, 314 on an enlarged scale. In the neutral position, i.e. in the closed state of the valve element 313 the latter sealingly adjoins the valve seat 317 assisted by the force of the compression spring 319 (Figure 27). The compression spring 319 is for this purposed centred on the housing side on a shoulder 323 whose end face 324 forms a stroke restriction for the valve element 313. A flow round the valve element 313 can then only take place when the pressurised fluid biasing the end face of the valve element 313 overcomes the counteracting force of the compression spring 319 and lifts the valve element 313 from the valve seat 317 (Figure 28). The pressurised fluid flows round the valve element 313 through only one overflow channel 321 which is provided parallel to a longitudinal axis 325 in the valve support 306. This one-sided flow round the valve element, marked by an arrow, causes the valve element 313 to be biased with force on one side. This ensures a stable positioning of the valve element 313 on a bore wall 326 - marked by two arrows - of the

valve support 306 whereby an unstable position, i.e. "fluttering open" of the valve element 313 is effectively eliminated.

In order to form the valve seat 317 the shoulder 315 is arranged in the valve support 316 so that the valve element 313 is supported on the shoulder 315 by its end face 327, i.e. radially off-set relative to the sleeve face of the valve element 313. The shoulder 315 is thereby chamfered at the end, i.e. the inner contact bearing area is adjoined by a recessed area, characterised by the angle "α". This design creates a linear sealing zone, i.e. a desired narrowly dimensioned sealing gap between the valve element 313 and the shoulder 315. Thus just a slight lift of the valve element 313 is sufficient to allow the pressurised medium to pass through, with a reduced flow resistance, and thus allows an accelerated flow round the valve element 313 through the overflow channel 321.

The shape of the valve support 306 ensures the pressurised medium flows in centrally to the end face 327 of the valve element 313. The inflow channel 328 has an inlet formed as a Venturi nozzle to improve the inflow. On the side of the valve element the inflow channel 328 forms the valve seat 317.

Radially off-set from the shoulder 315 is a ring channel 329 shaped as an undercut section and formed in the valve support 306 and adjoined by the overflow channel 321. As can be seen from Figures 27 and 28 a first section of the overflow channel 321a widens out radially continuously starting from the ring channel 329 and adjoined by a further section of the overflow

channel 321b whose cross-sectional profile remains constant over its length.

In a further embodiment (Figure 29) the component parts agreeing with the embodiments according to Figures 27 and 28 are provided with the same reference numerals so that for their description reference is made to the design of these embodiments (Figures 27 and 28).

As opposed to Figures 27 and 28, the valve element 333 according to Figure 29 has on both end faces 327 frusto-conical shoulders 330a, 330b. This design forms a centring shoulder both on the valve seat 317 and for the support of the compression spring 319. The arrangement of the frusto-conical shoulder 330a, 330b on both sides furthermore requires no position-orientated installation so that faulty fitting of the valve element 333 is ruled out. A further difference relates to the overflow channel 331 whose first section of the overflow channel 331a has a cross-section which widens out over the length and is adjoined by the overflow channel 331b having a clearly reduced cross-sectional enlargement in relation to the longitudinal extension.

Figure 30 shows in a view according to the direction of the arrow in Figure 29 the design of the overflow channel 331 in connection with the mounting 332 for the valve element 333. As a measure for achieving a favourable flow shape the individual segments of the overflow channel 31a, 31b are each formed in the shape of circular sections. The shaping is selected so that the cross-section of the overflow channel continuously increases in dependence on the stroke of the valve element, i.e. the opening state. Figure 30 clearly

shows the force exerted on the valve element in the direction of the arrow as a result of the one-sided flow round the valve element.

Figures 31 and 32 show through-flow characteristic lines of the damping devices. In the diagrams the volume flow is recorded on the abscissa and the pressure loss on the ordinate. The characteristic line curve for a damping device according to the invention can be seen from Figure 31 wherein the valve element already occupies a stable position in the opening phase, i.e. without any detrimental "fluttering open" of the valve element. The characteristic line curve for a damping device of the previous kind is shown in Figure 32. Apart from a clearly higher pressure loss the damping device known up until now shows a clear "fluttering open" of the valve element in the opening phase which leads to a disadvantageous noise development.

The patent claims filed with the application are proposed wordings without prejudice for obtaining wider patent protection. The applicant retains the right to claim further features disclosed up until now only in the description and/or drawings.

References used in the sub-claims refer to further designs of the subject of the main claim through the features of each relevant sub-claim; they are not to be regarded as dispensing with obtaining an independent subject protection for the features of the sub-claims referred to.

The subjects of these sub-claims however also form independent inventions which have a design independent of the subjects of the preceding claims.

The invention is also not restricted to the embodiments of the description. Rather numerous amendments and modifications are possible within the scope of the invention, particularly those variations, elements and combinations and/or materials which are inventive for example through combination or modification of individual features or elements or process steps contained in the drawings and described in connection with the general description and embodiments and claims and which through combinable features lead to a new subject or to new process steps or sequence of process steps insofar as these refer to manufacturing, test and work processes.

Patent Claims

1. Damping device, more particularly for damping pressure vibrations and/or pressure pulsations in a hydraulic operating system having at least one master and one slave cylinder and a pressure line connecting same wherein the damping device which is connected to a component part of the operating system and is loaded by a pressurised fluid comprises an at least one-piece housing characterised in that the volume of the housing can be expanded against the action of an energy accumulator.

2. Damping device, with which pressure vibrations or pressure pulsations in a hydraulic operating system for a shift and separate clutch in vehicles are dampened or eliminated, wherein the operating system comprises by way of example a manually operable clutch pedal which interacts with a master cylinder wherein the latter is connected through a pressure line to a slave cylinder acting on a release bearing of the shift and separate clutch, and the damping device which is connected to a component part of the operating system and can be loaded by a pressurised fluid comprises a housing which is in one piece or consists of at least two component parts wherein a closure body is inserted displaceable in the installation chamber of the housing, characterised in that the sealed closure body which is supported on a spring element is biased directly or indirectly by the pressurised fluid.

3. Device more particularly according to claim 1 and/or 2 characterised in that a damping characteristic of the damping device can be influenced by a geometric design of the closure body as well as by the design of

the spring element by means of a defined spring constant or a defined spring stiffness.

4. Device, more particularly according to one of the preceding claims characterised in that a piston or a ring piston is inserted in the damping device as the closure body.

5. Device, more particularly according to one of the preceding claims characterised in that at least one plate spring is provided as the spring element against which the piston or ring piston is resiliently supported.

6. Device more particularly according to one of the preceding claims characterised in that a coil spring is provided as the spring element on which the ring piston is supported.

7. Device more particularly according to one of the preceding claims characterised in that the coil spring has at least two spring windings.

8. Device, more particularly according to one of the preceding claims characterised in that the plate spring is centred on a cylindrical shoulder of the piston and is supported on an end wall or a restriction of the installation chamber.

9. Device, more particularly according to one of the preceding claims characterised in that the plate springs are mounted layered in the same direction or in alternating directions into a plate spring parcel for resiliently supporting the piston or ring piston.

10. Device more particularly according to one of the preceding claims characterised in that the installation chamber for holding the piston is provided in the one-piece housing in a section which is off-set from the supply of pressurised fluid.

11. Device more particularly according to one of the preceding claims characterised in that the installation chamber is closed by a cover which at the same time forms an end stop for the piston.

12. Device more particularly according to one of the preceding claims characterised in that in order to seal the piston the said piston has a ring groove or an end-side circumferential free area to hold a seal which on the outside sealingly adjoins a wall of the installation chamber.

13. Device more particularly according to one of the preceding claims characterised in that to form a housing a push-in part is inserted with keyed engagement into a socket part.

14. Device more particularly according to one of the preceding claims characterised in that the push-in part is fixed in position on the socket part by means of a sleeve.

15. Device more particularly according to one of the preceding claims characterised by a direct positive-locking fastening between the socket part and push-in part.

16. Device more particularly according to one of the preceding claims characterised in that the circular ring shaped installation chamber provided concentric with a pressurised medium guide in the housing or in the socket part thereof for holding the ring piston is connected to the pressurised medium guide through a thin channel.

17. Device more particularly according to one of the preceding claims characterised in that a seal is provided in front of the ring piston on the side facing the thin channel and with an inner dynamic sealing lip sealingly adjoins the shoulder and with an outer dynamic sealing lip sealingly adjoins a wall enclosing the ring piston.

18. Device more particularly according to one of the preceding claims characterised in that the ring piston is supported with damping action on at least one plate spring.

19. Device, more particularly according to one of the preceding claims characterised in that the ring piston is inserted in the circular ring-shaped installation chamber and is supported on the side remote from the installation chamber against a coil spring.

20. Device more particularly according to one of the preceding claims characterised in that the damping device has a throttle valve.

21. Device more particularly according to one of the preceding claims characterised in that a disc inserted between the socket part and push-in part is provided as the throttle valve.

22. Device more particularly according to one of the preceding claims characterised by a spring with which the first throttle valve is pretensioned in the direction of a throttle position.

23. Device more particularly according to one of the preceding claims characterised in that the damping device is inserted in the pressure line which connects the master cylinder to the slave cylinder.

24. Device more particularly according to one of the preceding claims characterised in that the damping device is combined with a master cylinder.

25. Device more particularly according to one of the preceding claims characterised in that the damping device is integrated in the slave cylinder directly or in the pressure pipe thereof.

26. Device more particularly according to one of the preceding claims characterised in that the damping device has two devices off-set from each other and with different damping characteristics.

27. Device for damping pressure vibrations in hydraulic systems, more particularly a hydraulic operating system for a shift and separate clutch for vehicles, provided with a master cylinder which is to be operated and which is connected through a pressure line to a slave cylinder which activates the shift and separate clutch, wherein the pressure line or any component part of the hydraulic operating system is connected to a damping member whose housing has a membrane which can be biased by a pressurised fluid,

characterised in that the membrane is formed as a cover fixed with keyed engagement on the housing made from plastics to thereby sealingly close the housing chamber.

28. Device more particularly according to one of the preceding claims characterised in that the pot-shaped membrane engages by a collar round a cylindrical shoulder of the housing.

29. Device more particularly according to one of the preceding claims characterised in that an end section of the collar engages behind the shoulder of the housing by flanged areas.

30. Device more particularly according to one of the preceding claims characterised in that the membrane is fixed by a snap-fit connection mounted between the collar and the housing.

31. Device more particularly according to one of the preceding claims characterised in that in order to seal the membrane a sealing ring is inserted in a circumferential groove or in a recess of the housing and in the installation position of the sealing ring is covered by the collar of the membrane.

32. Device more particularly according to one of the preceding claims characterised by a housing which is provided with two diametrically opposite pot-shaped membranes.

33. Device more particularly according to one of the preceding claims characterised by a membrane which is

provided with a cambered housing base which is formed curved towards the housing or to the outside.

34. Device more particularly according to one of the preceding claims characterised by a housing which is provided with two radially aligned pipeline connections.

35. Device more particularly according to one of the preceding claims characterised in that the housing is provided with two pipeline connections which are aligned matching each other at right angles to the membrane.

36. Device more particularly according to one of the preceding claims characterised in that the pressure lines are attached through push-fit connections to the pipeline connection of the damping member.

37. Device more particularly according to one of the preceding claims characterised by a damping member wherein the damping chamber is formed as a labyrinth.

38. Device more particularly according to one of the preceding claims characterised by a damping member whose housing has in connection with the membrane a defined softness in order to achieve a certain damping.

39. Device more particularly according to one of the preceding claims characterised by a damping member whose membrane is inserted in a housing recess wherein this is supported on a contact bearing face, and a security ring is mounted in front of the membrane and in order to fix these component parts an edge on the

side of the housing is flanged inwards at least in sections.

40. Device more particularly according to one of the preceding claims characterised by a seal which is inserted in an end circumferential ring groove of the contact bearing face and which in the installed state adjoins the membrane with pretension.

41. Device more particularly according to one of the preceding claims characterised by a damping member which is connected to a component part of the hydraulic operating system such as the master cylinder, the slave cylinder or the pressure line or is integrated in one of these component parts.

42. Damping device for pressure vibrations or pressure pulsations in hydraulic systems, more particularly a hydraulic operating system for a shift and separate clutch in a vehicle, wherein the operating system comprises a master cylinder and is connected through a pressure line to a slave cylinder which activates the shift and separate clutch, wherein the damping device which is connected to the operating system comprises a housing, with at least one pipeline connection and a membrane as well as a security element which forms a lift restriction for the membrane characterised in that a recess surrounded by an edge is formed in the housing to hold the membrane in front of which is mounted a security element which is fixed in position.

43. Damping device for pressure vibrations or pressure pulsations in hydraulic systems, more particularly a hydraulic operating system for a shift and separate clutch for vehicles, wherein the operating system

comprises a master cylinder and is connected through a pressure line to a slave cylinder which activates the shift and separate clutch, wherein the damping device which is connected to the operating system comprises a housing, with at least one pipeline connection and a membrane as well as a security element which forms a lift restriction for the membrane characterised by a housing made from plastics which is combined with a membrane of spring steel as well as a security element of plastics or steel which encloses the membrane.

44. Damping device for pressure vibrations or pressure pulsations in hydraulic systems, more particularly a hydraulic operating system for a shift and separate clutch for vehicles, wherein the operating system comprises a master cylinder and is connected through a pressure line to a slave cylinder which activates the shift and separate clutch, wherein the damping device which is connected to the operating system comprises a housing, provided with at least one pipeline connection and a membrane as well as a security element which forms a lift restriction for the membrane characterised by a disc-like housing which is integrated together with the membrane in a pot-shaped security element.

45. Device more particularly according to one of the preceding claims characterised in that the pipeline connections are mounted within a circular outer contour of the housing.

46. Device more particularly according to one of the preceding claims characterised by a housing made of aluminium, preferably as a flow pressed part in which a membrane made of spring steel as well as a security element made of metal material are integrated.

47. Device more particularly according to one of the preceding claims characterised by a security element having a centre passage which in a neutral position of the membrane is guided up to the membrane whilst keeping a gap width "s".

48. Device more particularly according to one of the preceding claims characterised by a security element whose edge encloses an outer region of the housing and whose free end angled inwards in the installed position engages behind a shoulder of the housing.

49. Device more particularly according to one of the preceding claims characterised in that the edge is fixed by a snap-fit connection with keyed engagement on the cylindrical sleeve face of the housing.

50. Device more particularly according to one of the preceding claims characterised by a material-bonding connection between the edge of the security element and the housing.

51. Device more particularly according to one of the preceding claims characterised in that to seal the membrane a sealing ring is inserted at the end side into a circumferential groove of the housing which is supported sealingly on the membrane in the installed position.

52. Device more particularly according to one of the preceding claims characterised in that between the housing and the edge of the security element a sealing ring is inserted into a ring groove of the housing and

in the installed position is supported with pretension sealingly on the inside against the edge.

53. Device more particularly according to one of the preceding claims characterised in that a disc-like security element having a conical outer contour is provided as the membrane holder and is inserted in a corresponding recess of the housing and in the installed position is connected through material bonding to the housing in the region of the contact bearing surface which is defined by the recess.

54. Device more particularly according to one of the preceding claims characterised by a housing in which two parallel spaced membranes are inserted which are each associated on the outside with a security element.

55. Device more particularly according to one of the preceding claims characterised by a housing whose pipeline connections are aligned at right angles to the membrane.

56. Device more particularly according to one of the preceding claims characterised in that a damping chamber of the housing closed at the side by the membrane is formed as a labyrinth.

57. Device more particularly according to one of the preceding claims characterised in that the damping device is integrated in one of the component parts of the hydraulic operating system or is connected thereto, such as the master cylinder or the slave cylinder as well as the pressure line.

58. Device more particularly according to one of the preceding claims characterised in that the membrane and the security element are fixed in position at least through a section of the edge being flanged over or angled.

59. Device for damping pressure vibrations or pressure pulsations, more particularly in a hydraulic operating system of a shift and separate clutch of vehicles, comprising a valve support on which two valve elements are supported radially off-set and biased by spring force, each forming with the valve support a valve seat wherein the cylindrically shaped valve elements associated with different flow directions of the pressurised fluid are guided in the valve support and each valve element in the valve support is assigned an overflow channel which is mounted parallel to a longitudinal axis and whose cross-section is enlarged at least in part in dependence on the longitudinal extension or on the opening stroke of the valve element.

60. Device according to claim 59 wherein in order to form the valve seat the valve support has an inflow channel which is reduced in diameter compared to that of the valve element and has an axially protruding shoulder on which the valve element is supported by an end face inwardly off-set radially relative to its outer contour.

61. Device according to claim 60 wherein an undercut section designed as a ring channel is formed in the valve support off-set relative to the shoulder.

62. Device according to claim 61 wherein the overflow channel starting from the ring channel is enlarged continuously over the entire longitudinal extension.

63. Device according to claim 59 whose overflow channel has a first section which increases proportional to the stroke of the valve element, and is adjoined by a second section whose cross-section increases proportional to the stroke of the valve element.

64. Device according to claim 59 wherein a maximum cross-section of the overflow channel exceeds the cross-section of the inflow channel of the damping device.

65. Device according to claim 60 wherein the inflow channel is formed on the end remote from the valve seat as a Venturi nozzle.

66. Device according to claim 59 wherein the overflow channel has a circular arc-shaped cross-sectional profile.

67. Device according to claim 59 wherein the valve element is provided on both end faces with frusto-conical shoulders.

68. Device according to claim 60 wherein the axially protruding shoulder of the valve support forms an inclined or conical surface characterised by the angle "α" on which the end face of the valve element is supported.

69. Device according to claim 59 wherein the compression spring is centred in position on the frusto-conical shaped shoulder on the side of the valve element remote from the valve seat.

70. Device according to claim 68 with a rotationally symmetrical shaped valve element which eliminates the need for a directional assembly.

71. Device according to claim 59 wherein the compression spring is centred in the housing on a component part which is associated with the valve support and for this purpose has a shoulder whose end face forms an end stop for the valve element.

72. Device according to claim 59 wherein the valve element is guided displaceable in the valve support with an installation play of > 0.01 mm.

73. Device according to claim 59 having a sealing element made of steel, as well as a valve support of plastics which are integrated in the plastics housing.

74. Damping device for damping vibrations or pulsations in a hydraulic circuit substantially as herein described with reference to any one embodiment shown in the accompanying drawings.

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Application No: GB 0004366.1
Claims searched: 1 to 26 and those claims appended thereto
Examiner: Mike Mckinney
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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R):

Int Cl (Ed.7):

Other: ONLINE: WPI; EPODOC; JAPIO.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2254374 A	(AUTOMOTIVE PRODUCTS) see whole specification.	1 to 9, 12 to 16 and 18 to 25 at least.
X	GB 2246819 A	(AUTOMOTIVE PRODUCTS) referred to on page 4 of the specification.	1, 3, 23, 25 and 26.
X	GB 2012872 A	(TOYOTA) see whole specification.	1 to 4, 6, 7, 10 to 12, 19 and 20 at least.
X	US 5320203	(WILBER et al.) see whole specification.	1 to 9 and 12 to 25 at least.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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